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ASME Annual Meeting — Atlantic City, N. J., November 25-30, 1951

Leesburg, Florida, plant of Minute Maid Corporation, showing outdoor installation of B & W Integral-Furnace Boiler.

pioneering with B&W Steam

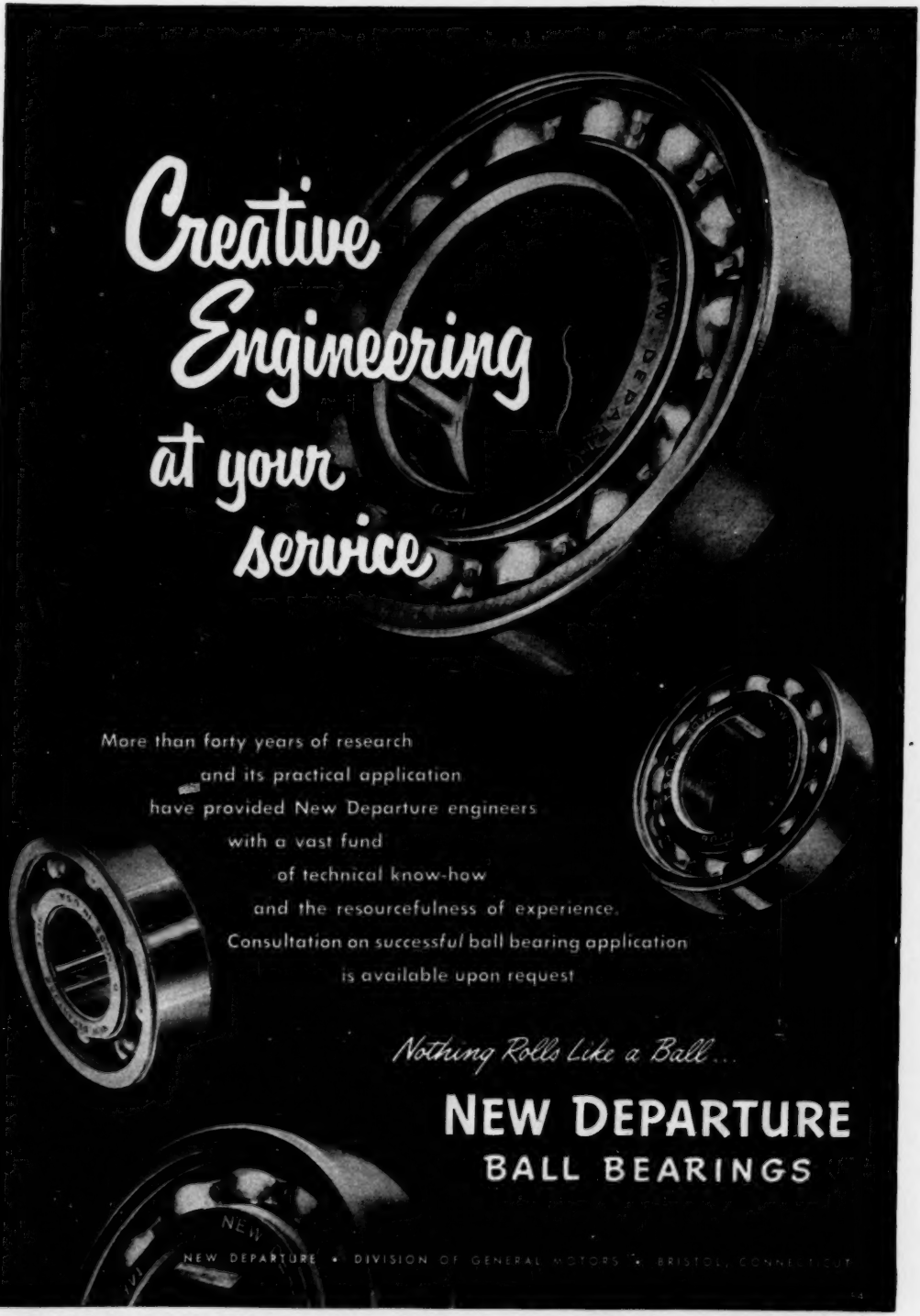
As leaders and innovators in the high-vacuum method of concentrating citrus juices . . . as part of a thriving Florida industry, expecting a 35% growth over the next three years . . . Minute Maid Corporation appreciates the importance of economical first-cost, and operation of its equipment at peak-level efficiency.

For example, Minute Maid's modern Leesburg, Florida, plant is equipped with a new B&W Integral-Furnace Boiler, Type FF. Rated at 46,000 lb. per hr. of dependable, low-cost steam, this highly efficient unit is oil-fired by B&W steam-atomizing Y-jet burners. And the entire unit is installed out of doors, at considerable first-cost savings. Minute Maid reports performance in keeping with their highest expectations.

Remember—when planning your company's next expansion, modernization, or new plant—that the B&W Integral-Furnace Boiler family includes designs ranging from as little as 2,800 lb. of steam per hr. up to 350,000 lb. per hr., and larger. The Babcock & Wilcox Company, 85 Liberty Street, New York 6, N. Y.

BABCOCK & WILCOX

G-494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NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

MECHANICAL ENGINEERING, November, 1951, Vol. 73, No. 11. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

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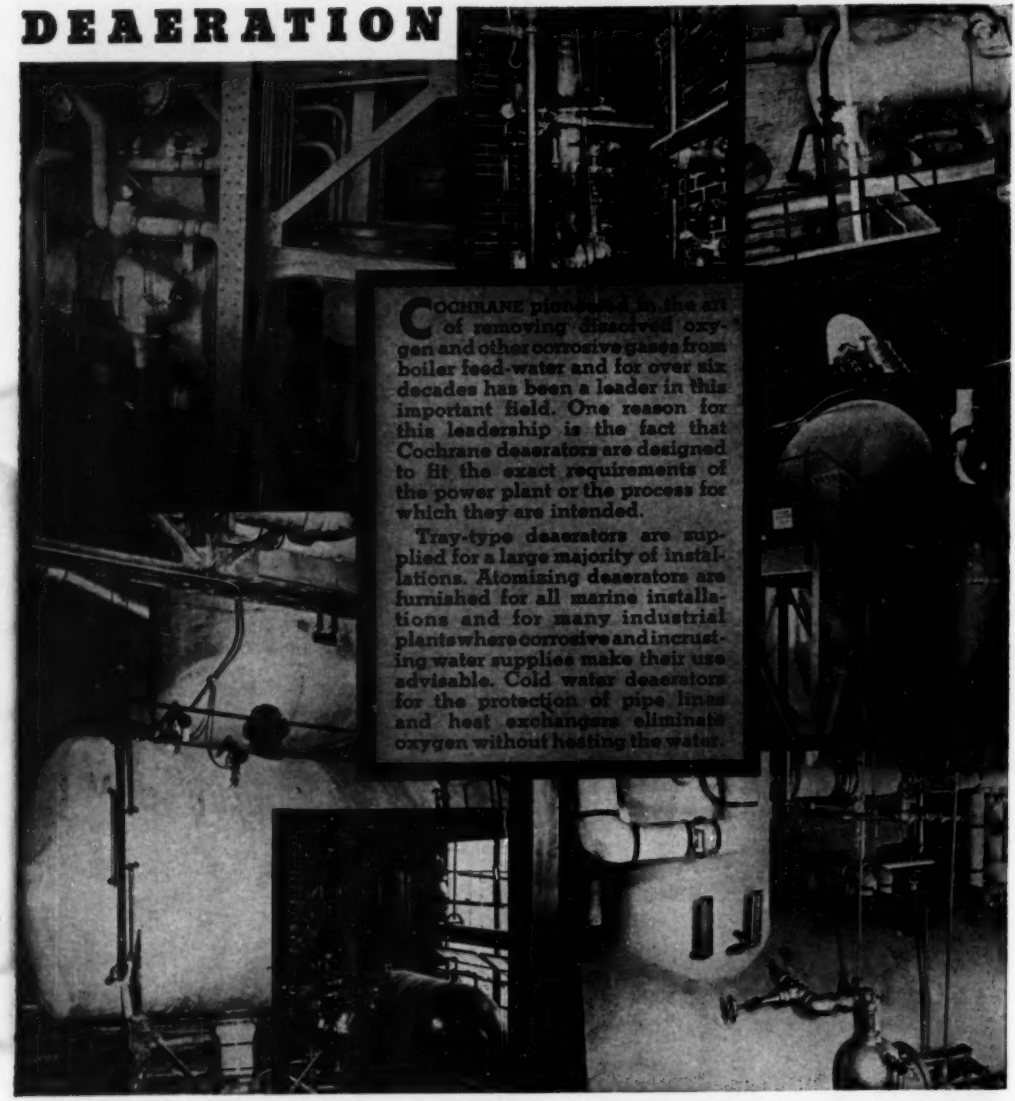
DEAERATION



COCHRANE pioneered in the art of removing dissolved oxygen and other corrosive gases from boiler feed-water and for over six decades has been a leader in this important field. One reason for this leadership is the fact that Cochrane deaerators are designed to fit the exact requirements of the power plant or the process for which they are intended.

Tray-type deaerators are supplied for a large majority of installations. Atomizing deaerators are furnished for all marine installations and for many industrial plants where corrosive and incrusting water supplies make their use advisable. Cold water deaerators for the protection of pipe lines and heat exchangers eliminate oxygen without heating the water.

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In Canada: Canadian General Electric Co., Ltd., Toronto • In Mexico: Babcock & Wilcox de Mexico, S. A., Mexico City • In Europe: Recuperation Thermique & Epuration, Paris

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LINE-O-POWER STRAIGHT-LINE DRIVES
Economical in original cost and operation. Duti-Rated Gears have file-hard tooth surfaces and ductile cores, assuring long life. Double or triple reductions, with ratios from 5 to 1 up to 238 to 1 and capacity range from 1 up to 200 horsepower.

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- ☐ Bulletin LPB Line-O-Power Straight Line Drives
- ☐ Bulletin MPB Maxi-Power Helical Gear Drives
- ☐ Bulletin GMA Foote Bros.-Louis Allis Gearmotors
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Name..... *Position*.....
Company.....
Address.....
City..... *Zone*..... *State*.....

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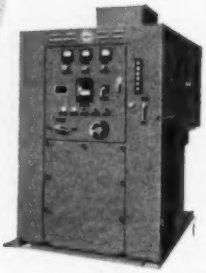
Better Power Transmission Through Better Gears

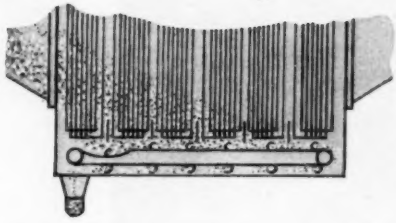
Let's be practical about precipitators

1



This Koppers "packaged" mechanical or vacuum tube power pack is not restricted to an area near the precipitator. It can easily be installed in any convenient place in the plant. Result: Compact designs! More flexibility!

2



This Koppers exclusive—the bottom drag scraper—provides continuous dust removal. Cumbersome hoppers are eliminated and dust handling is simplified. Result: Lower operating costs! Less space requirement!

Here are two ways Koppers engineers simplify precipitator operation for you!

PERFORMANCE GUARANTEED!

Koppers engineers protect your investment in an electrostatic precipitator by guaranteeing both the recovery or gas-cleaning *efficiency* and the *residual content* left in the gas after cleaning. Koppers-Elex electrostatic precipitators are designed, engineered, fabricated, erected and guaranteed *under one contract* by Koppers Company, Inc.

IN ADDITION to high efficiency, Koppers concentrates on the practical aspects of electrostatic precipitator design. Shown above are just two of the many practical features which simplify operation.

Besides these compact power packs and the continuous dust removal features, Koppers-Elex electrostatic precipitators may be of the multiple-chamber type. This means one chamber may be shut down for inspection or maintenance without stopping the gas-cleaning action. The dirty gas is simply diverted through other chambers where cleaning continues.

Because rapping is *sectionalized*, re-entrainment is minimized. And because successive collection fields can be separately *energized*, maximum voltage can be applied to each field—with higher gas-cleaning efficiency resulting. Pressure drops are negligible.

IF YOU HAVE A GAS-CLEANING PROBLEM, write and outline the details for us to review. There is no obligation. Just address your letter to: KOPPERS COMPANY, INC., *Precipitator Dept.*, 321 Scott Street, Baltimore 3, Maryland.

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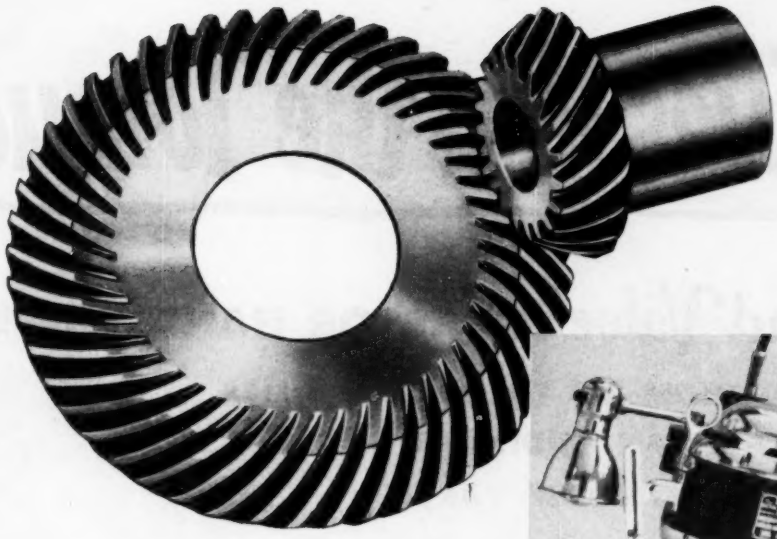

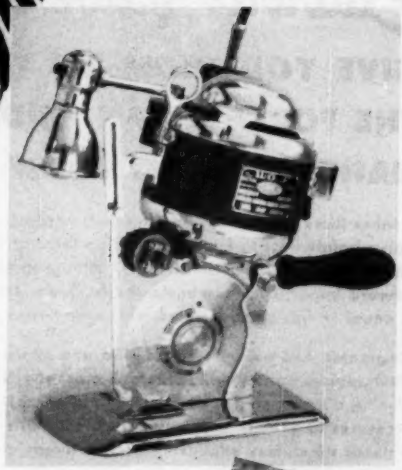

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The Wolf Machine Company designs their cloth cutters "for the special convenience of the operator, to insure the highest production with a minimum of effort." Sixty years of manufacturing to highest precision standards has won an enviable quality reputation for these fine machines.

G.S. is especially pleased to have been chosen to mass produce the Fractional Horsepower Gears for Wolf Machines. We accept this responsibility secure in the knowledge that G.S. skill and experience will uniformly produce Gears to meet their most exacting specifications.

If you, like the Wolf Machine Co., are extremely particular about the Small Gearing you use, then by all means, entrust the job to G.S.! You see . . we've *specialized* in making *better* Fractional Horsepower Gears for more than 30 years. More and more quality-minded manufacturers from coast-to-coast look to us for their needs. Let us give you ideas, suggestions, or cost estimates. Mail us drawings or specifications today!

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Free new 6-page folder illustrating and describing G.S. facilities, Small Gearing and applications, together with handy charts. Will you ask for it on company stationery, please?

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GIVE YOU FROM 2.8 TO OVER 12 TIMES THE FORCE OF AN ORDINARY HANDWHEEL TO CLOSE VALVES

It takes three strong men, pulling their hardest, on an ordinary valve handwheel to equal the closing force of ONE man using an Edward 16" Impactor Handwheel. With progressively larger size Edward Impactor Handwheels, the force available to close a valve is equal to six, eight, ten and, yes, *even twelve men.*

Originated and patented by Edward and improved through the years, the Impactor handwheel is the one most effective means of manually closing a valve so it is absolutely tight against high operating or test pressures in power, petroleum, chemical, marine, or industrial plants. It needs no clumsy expensive gear or toggle construction, or the use of extension levers or cinch bars for actuating.

Its space-saving design allows piping designers great latitude in locating valves, walkways and operating platforms.

But most important, the Edward Impactor handwheel means sure, fast operation of valves—big or little—in an emergency or under normal operating conditions by a single man. It saves manpower by giving ONE man more power. NOW standard equipment on most 900, 1500 and 2500 lb Edward Valves, 2½ inches and up.

The Impactor principle is simple. Two heavy lugs are cast on the underside of the wheel: a sharp turn of the wheel causes these lugs to strike simultaneous blows against a steel cross arm, locked to the stem or revolving EVAthrust yoke bushing. Write for full facts, Edward Valves, Inc. 1350 W. 145th Street, East Chicago, Indiana.

WOMANPOWER BEATS MANPOWER!

Many smaller size Edward valves are available with the new Impactor Handle (right in photo) for greatest closing efficiency. Design principle is same as Impactor handwheel, and test gages prove it too gives you the torque of six hands or 2.8 times the closing force of an ordinary handwheel. You know the valve is closed absolutely tight with an Edward Impactor Handle.

FEATURES LIKE THIS SAVE YOU MONEY AND WORK....

That's why it pays to specify Edward Valves.

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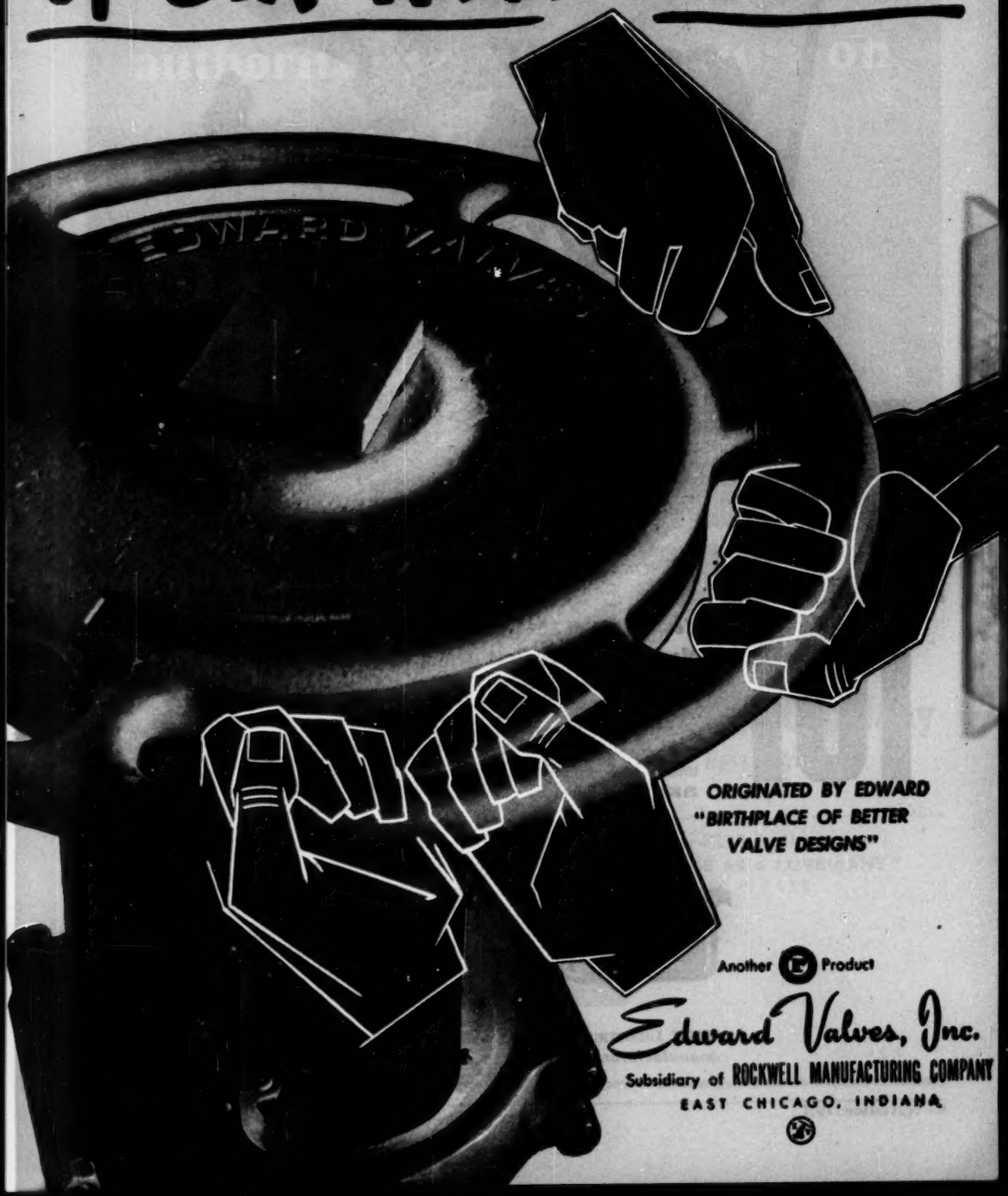

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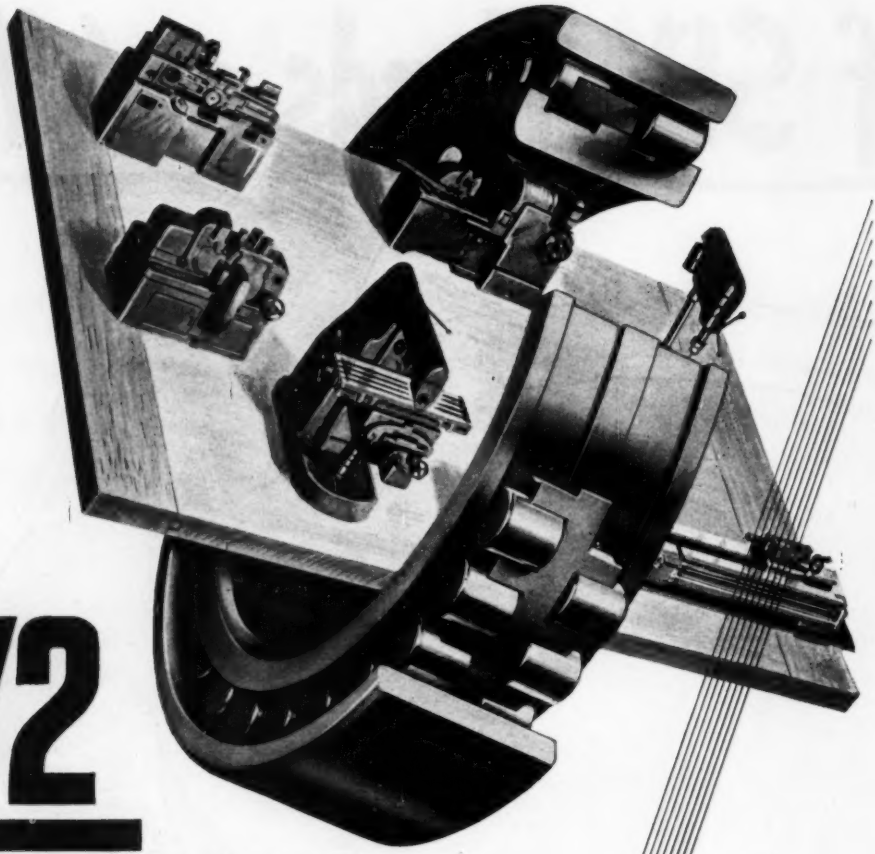

72/101

Yes, 72 out of 101 Machine Tool Builders* use SKF BEARINGS.

This acceptance of **SKF** Bearings to help provide the highest accuracy under severe conditions is typical of **SKF**'s acceptance by *all* industry.

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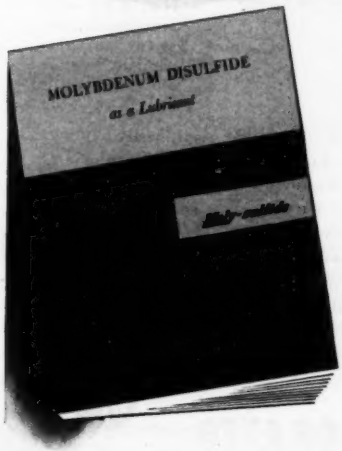

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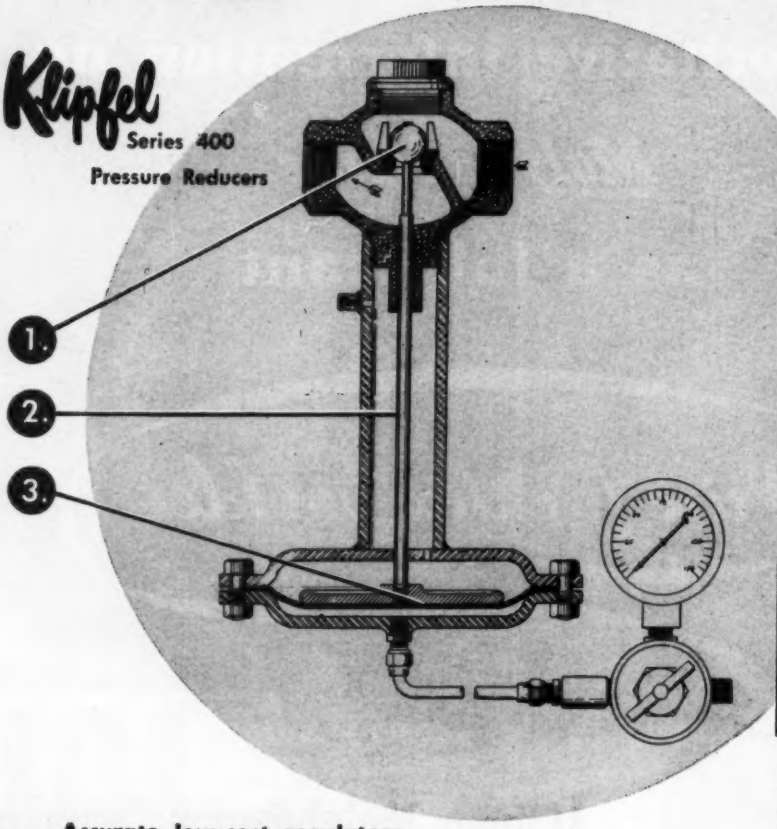

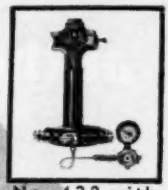

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FOR longer service with negligible maintenance, operating parts are reduced to just three, inner valve, stem and diaphragm, in the Klipfel 400 Series air-loaded Pressure Reducing Valves. In addition, these 400 Series Valves provide exceptionally close regulation for an unusually low initial cost.

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For full data on the Klipfel 400 Series Valves, for steam, air, water or gas, write Dept.CM-11 for Bulletin No. 148.

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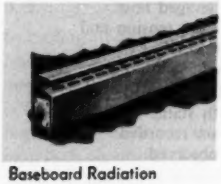
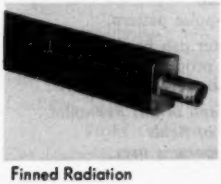
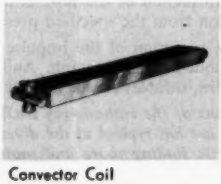


Baseboard Radiation

Hot Water Coil



Finned Radiation



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COURTESY UNITED STATES RUBBER CO.

With its slow, driven sweeps, and d-c amplification, the Du Mont Type 250-AH CATHODE-RAY OSCILLOGRAPH is an important key to the accuracy of this "fatigue test," and to the proper operation of the impulse-test equipment.

an approved hydraulic impulse test

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Thirty five times a minute, for fifty continuous hours, test lengths of the hydraulic hose are subjected to controlled dynamic pressure pulses which rise to 150% of rated pressure. Air-aged, oil-aged, and unaged hose is impulse-tested under conditions of excessive tension and unusual compression and must withstand the stresses applied under these hydraulic shocks without exhibiting fatigue.

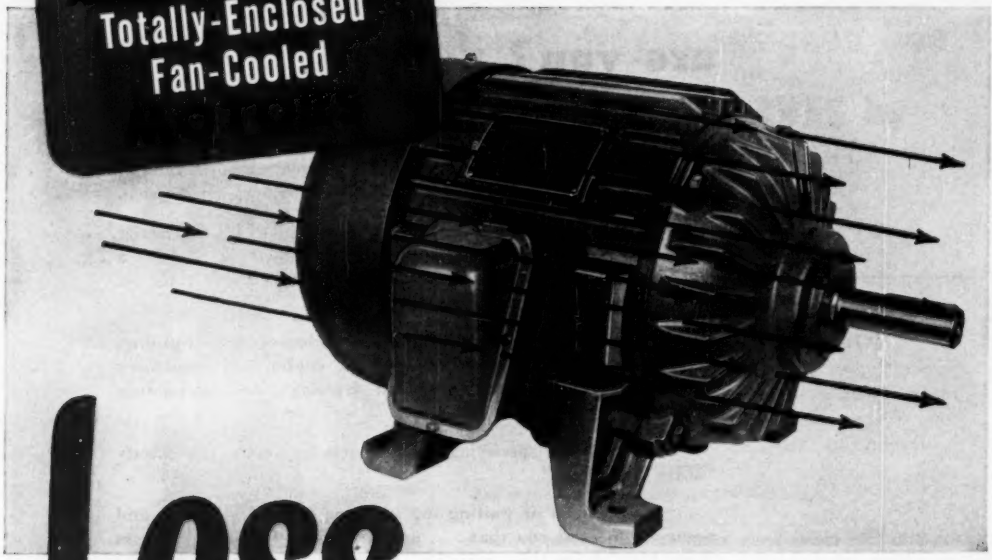
Simultaneously, each control-impulse cycle is applied to the cathode-ray oscillograph, where both static and dynamic levels of the pressure pulse are recorded. And, because the pressure pattern can be observed in complete detail on the cathode-ray oscillograph, slightest deformation of the hose is detected as a deviation from the specified pressure-pulse pattern.

Also, faulty operation of the Impulse Tester can be detected on the cathode-ray oscillograph. And by proper interpretation of this pattern, troubles can be localized and corrected quickly.

The functions of the cathode-ray oscillograph in this hydraulic application are but typical of the diversity of fields in which it is finding more and more important uses.

DUMONT *for Oscillography*

Allen B. Du Mont Laboratories, Inc., Instrument Division, 1000 Main Ave., Clifton, N. J.



Less MOTOR CLEANING ...INSPECTION...OVERHAUL!

HERE'S A MOTOR that actually blows itself clean! Dirt is carried away by cooling air blown over the ribbed cast iron frame and bearing housings of this new Allis-Chalmers tefc motor.

Dirt can't build up to cause overheating. Concealed air passages and pockets have been eliminated. Even oily dirt that sticks can simply be wiped or blown off.

And this means savings! Maintenance costs are traditionally low on totally-enclosed, fan-cooled motors. But they're lower than ever before on the new Allis-Chalmers Type APZ tefc motor.

Rigid Construction

The frame is cast iron which has high resistance against corrosion and distortion. Bearings are pre-lubricated at the factory and should need no attention for years. Tapped holes with pipe plugs to permit regreasing and to provide grease relief are standard equipment.

Get All The Facts

The new Allis-Chalmers Type APZ totally-enclosed, fan-cooled motor is built in all NEMA standard frame sizes from 224* to 505. Also in explosion-proof type. Your A-C Authorized Distributor or District Office has complete information. Call today, or write Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 51B7225.

A-3426

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CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and *Vari-Pitch* sheaves, speed changers.

PUMPS — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

Texrope and Vari-Pitch are Allis-Chalmers trademarks.

ALLIS-CHALMERS

*Similar design non-ventilated motors Type APK, also available in frames 203 to 224 inclusive.

How good a waiter are you?

Do you burn up when the wife keeps you waiting? Do you pace the floor when the whole job waits on one valve? Then, listen.

We've got a machine . . . a refrigerating machine. It's the Carrier 100 and 150 hp. Reciprocating Refrigerating Machine. And it's a complete refrigeration system for cooling water or brine . . . for air conditioning or industrial processes.

You get a compressor, a cooler, a condenser, precut piping, valves, control panel, selective fittings, cooler and condenser stands, heat exchanger, foundation drawings, and foundation bolts and sleeves.

So instead of specifying a lot of nuts and bolts, you specify "30B4" or "30B6."

And, instead of waiting for someone to send you this, and someone to send you that . . . and winding up waiting, you get everything at one time from us.

Sound good? There's more. The Carrier Reciprocating Refrigerating Machine costs less than if you assembled your own. And, oh yes, it's a lot better machine. It's factory engineered—and we stand behind it. A little booklet has the full facts. Write for it. Carrier Corporation, Syracuse 1, New York.

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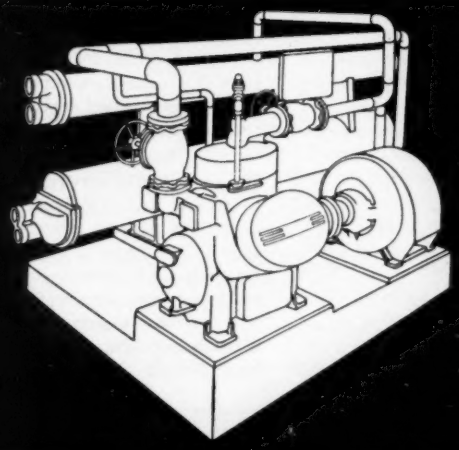
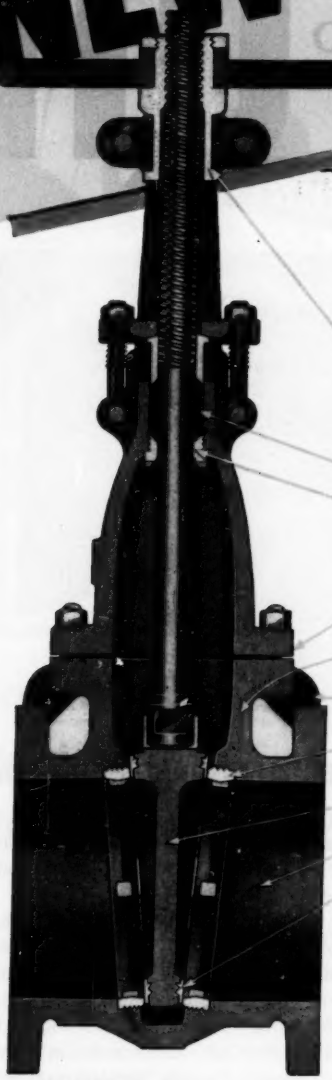
AIR CONDITIONING
REFRIGERATION
INDUSTRIAL HEATING



The Carrier Reciprocating Refrigerating Machine is adaptable to electric motor, gas or diesel engine and steam turbine drive.

NEW . . . a completely redesigned line of IRON VALVES by OIC



NOW the workhorse of the family—OIC's iron valve—offers you features formerly found only in steel valves. It's a brand new valve built around more than a third of a century's experience in making iron valves. We kept only the old handwheel.

Examine these construction details:

1 Lubricated yoke bushing, renewable without removing bonnet.

2 Deeper stuffing box; longer packing life.

3 Inserted back seat bushing permits repacking under full pressure.

4 Stronger body-bonnet joint; uniform gasket compression.

5 Better metal distribution, reduced weight, increased strength.

6 Sturdy tie-ribs; added resistance to pipeline stresses.

7 End-seated bronze seat rings will not loosen in service.

8 I-Beam type solid wedge, accurately guided.

9 Straight-through port areas reduce flow resistance.

10 Rolled-in seat facings on wedges give longer life.

OIC's new line of Iron Valves gives you longer service, lower upkeep and greater security. For Bulletin 805 telling you all about them, call your local OIC distributor or write The Ohio Injector Company, Wadsworth, Ohio.

OIC FOUNDED 1883

VALVES

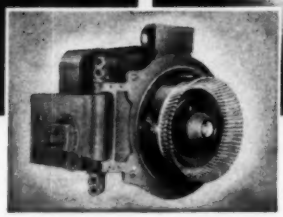
FORGED AND CAST STEEL · IRON · BRONZE

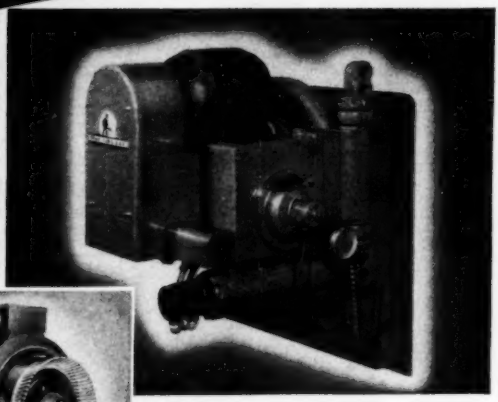
from GAS to OIL

in a matter of minutes

and vice-versa

Above, the Iron Fireman Ring Type gas burner takes over the firing job, with the Iron Fireman Horizontal Rotary oil burner swung back from firing position on boiler front. Right, firing end of Iron Fireman combination gas-oil burner.





Above, Iron Fireman Horizontal Rotary oil burner in firing position. Removal of center plate in gas burner permits insertion of oil burner nozzle in center of gas ring. For long periods of oil firing, gas ring is customarily removed.

Meet fuel emergencies with IRON FIREMAN combination firing

Only a few minutes notice is required to switch from one fuel to another. The Iron Fireman gas-oil burner guards your buildings or plant against sudden fuel emergencies, or against daily or seasonal gas shortages due to peak demands. You may also take advantage of changing fuel prices or seasonal rates.

The Iron Fireman Ring Type gas burner operates equally well with natural, manufactured or mixed gas, or with forced or natural draft.

The Iron Fireman Horizontal Rotary oil burner fires any grade of oil without special adjustment, from lightest to heaviest (No. 6). The exclusive Iron Fireman Oil Volumeter maintains extremely accurate oil flow regardless of changes in oil viscosity. Heat-rich, low-cost industrial oils can be fired as easily as the refined domestic oils.

Every installation is engineered for most efficient application to your individual requirements. Sales and engineering service throughout U. S. and Canada.

Write for 16-page illustrated booklet and specification sheets, to Iron Fireman Mfg. Co., 3152 W. 106th St., Cleveland 11, Ohio. Other plants in Portland, Oregon; Toronto, Canada. Dealers everywhere.

IRON FIREMAN

OIL, GAS and COAL FIRING FOR POWER, PROCESSING OR HEATING

IT ALWAYS PAYS TO SPECIFY

LADISH

Controlled Quality

PIPE FITTINGS

TO MARK PROGRESS

...where flow efficiency is a vital factor

You can depend on Ladish Controlled Quality Fittings to maintain maximum flow characteristics of any piping system . . . and do it consistently year after year. For advanced Ladish engineering assures the true circularity, full effective radii and smooth inner surfaces necessary to keep turbulence and friction loss at a minimum . . . features which are doubly safeguarded by the high, inflexible standards of Ladish Controlled Quality.

THE COMPLETE *Controlled Quality* FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

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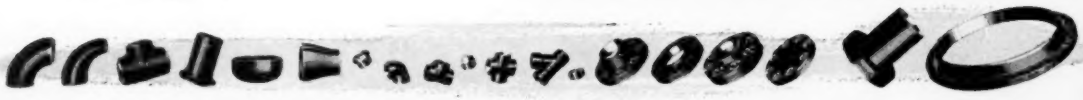


1500 Pounds at 1000°F.

Vogt

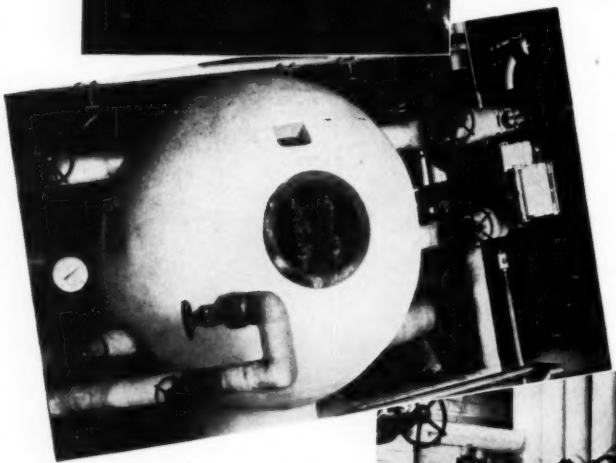
DROP FORGED STEEL

CHROME-MOLY STEAM VALVES

Hold the line at...

Oswego, N. Y. Station of

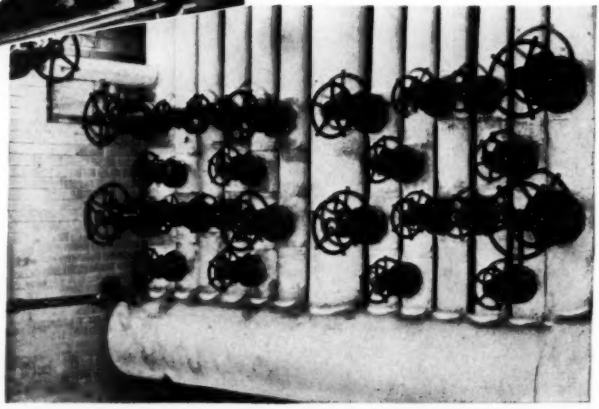
* NIAGARA MOHAWK POWER CO.



Leading central stations know and trust Vogt drop forged steel chrome-moly valves in their toughest high pressure and high temperature services.

Specify Vogt . . . and be SURE!

******The Huntley Station at Buffalo and Dunkirk Station at Dunkirk, N. Y. use many Vogt valves.*



TOP: Air view of Oswego, N. Y. Station of Niagara Mohawk Power Co.

CENTER: Valves on main drum of 875,000 pounds per hour steam generator.

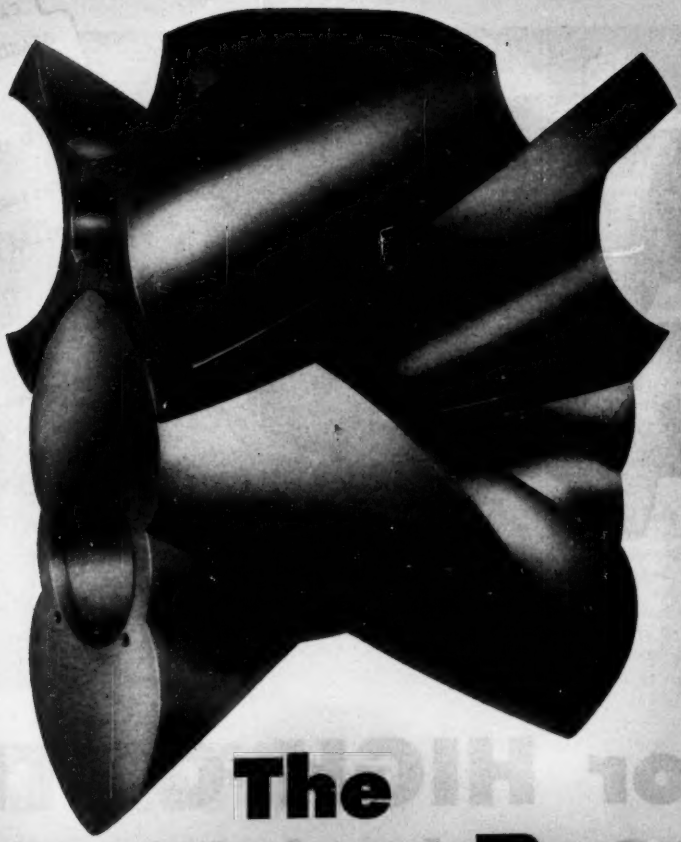
RIGHT: Drains from main steam, attemperator, and superheater lines employ a maze of valves.

NEW CATALOG F-9

Consult its 400 pages for the complete Vogt line of drop forged steel Valves, Fittings and Flanges for steam, water, oil, gas, air and refrigeration services.

HENRY VOGT MACHINE CO., Louisville 10, Kentucky

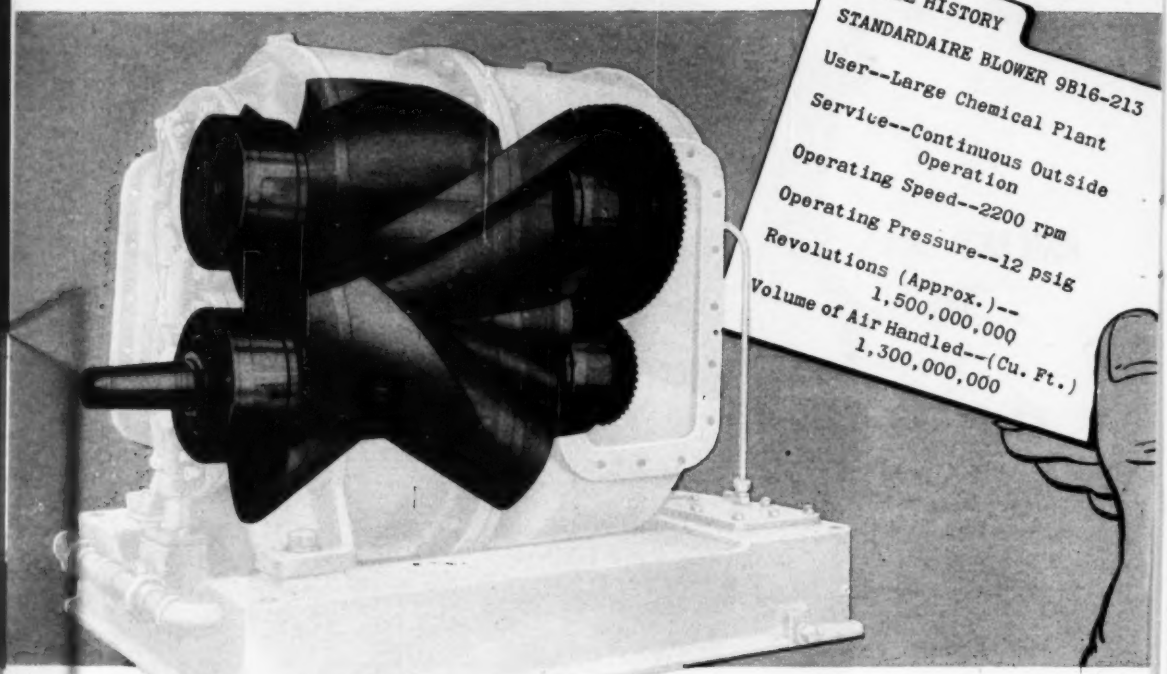
BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS, CHARLESTON, W. VA.



The STANDARDAIRE BLOWER

After HANDLING 1 1/3 BILLION cu. ft. OF HIGH PRESSURE AIR

Standardaire #9B16 • • • YEARS

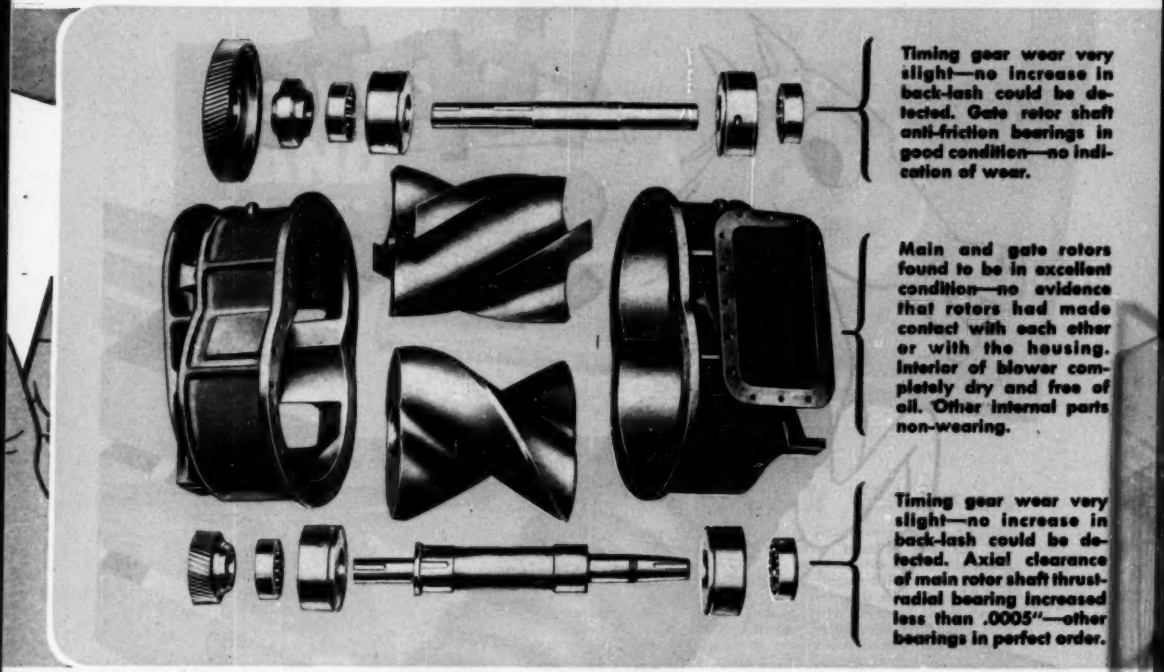


• For HIGH OUTPUT *Standardaire Blowers*

STANDARDAIRE—IT'S BUILT TO "TAKE IT"— Rarely does a manufacturer have an opportunity to measure the efficiency and quality of his product after a period of continuous trouble-free service. In a recent instance, however, Read Standard had such an opportunity and now releases the performance data on Standardaire Blower 9B16-213. This blower operated in a large Chemical Plant for a period of fifteen (15) months—24 hours a day—at a speed of 2200 rpm—pressure 12 psig—air delivery 1950 cfm. During fifteen (15) months of operation it is calculated that the Standardaire Blower handled 1⅓ BILLION cubic feet of high pressure air and made approximately 1½ BILLION revolutions—equivalent to over 20 years service for the average lobe type blower (40 hours per week at 500 rpm). The need for a still greater volume of air in their system prompted the chemical company to install a larger Standardaire Blower. The used blower was then sealed and returned to the factory for inspection.

STANDARDAIRE—INSPECTION AFTER 15 MONTHS SERVICE: Even after the hard and difficult service this blower performed it was found to be in excellent condition when dismantled and inspected in the presence of the chemical company's representative. No oil leaks had developed and the internal parts were completely dry and free of oil. Pump circulated oil was used for lubrication. The main and gate rotors were in perfect shape and showed no indication of wear. Neither was there any evidence that the rotors had made contact with each other or with the housing. Combination thrust radial bearing on the main rotor shaft carried the heaviest load due to thrust created by the main rotor. The actual clearance in this bearing was checked with a dial

# of performance in 15 months Service


Timing gear wear very slight—no increase in back-lash could be detected. Gate rotor shaft anti-friction bearings in good condition—no indication of wear.
Main and gate rotors found to be in excellent condition—no evidence that rotors had made contact with each other or with the housing. Interior of blower completely dry and free of oil. Other internal parts non-wearing.
Timing gear wear very slight—no increase in back-lash could be detected. Axial clearance of main rotor shaft thrust-radial bearing increased less than .0005"—other bearings in perfect order.

LONG LIFE----
have STAYING POWER

indicator and it was found that it had increased less than .0005". The other anti-friction bearings were found to be in perfect condition. Gear wear was so small that no increase in backlash could be detected. Even at the extremely high peripheral speed of these gears they were found to be very quiet in service.

STANDARDAIRE—FOR THAT EXTRA LIFE: This factual information is presented to acquaint the users of blower equipment with the extra life built into all Standardaire Blowers. Read Standard offers industry a wide range of axial flow, positive displacement blowers. They are modern in design—superior in performance—dependable in operation. For staying power and maximum efficiency it's the Standardaire Blower. For further information write Dept. E-19.

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370 Lexington Ave., New York 17, N.Y.

Be sure to visit our exhibit Booth 280
23rd EXPOSITION CHEMICAL INDUSTRIES
GRAND CENTRAL PALACE
NOV. 26 TO DEC. 1
See the Standardaire Blower in operation

AXIAL FLOW STANDARDAIRE BLOWER

BLOWER-STOKER DIVISION

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Pep to Spare
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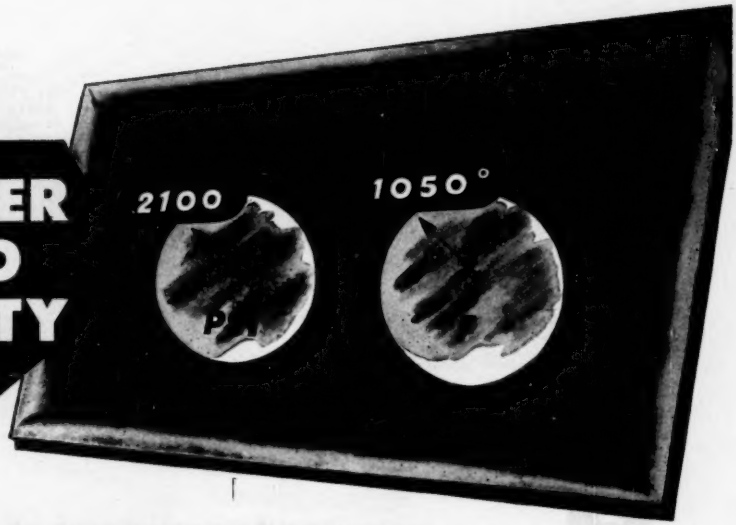
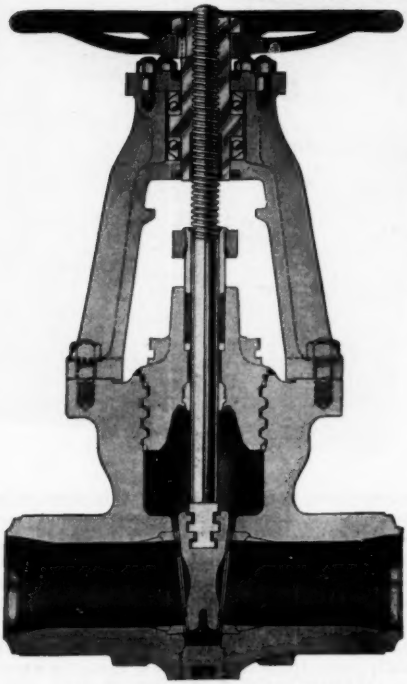
A DIVISION OF ASSOCIATED SPRING CORP.
The William D. Gibson Co.
1800 CLYBOURN AVE.
CHICAGO 14, ILL.

POWER AND SAFETY



WITH **LUNKENHEIMER**

Breech Lock Valves



VENTURI OR FULLWAY ENDS

1500 LB. CAST-STEEL BREECH LOCK GATE VALVE

Your high-pressure, high-temperature lines are *safely* controlled with leak-proof Breech Lock steel valves, rated at 1500 lbs. S.P. and used in central power stations at pressures up to 2100 lbs. or 1050°F. The exclusive Breech Lock design follows the principle used on large guns, except that locking is not accomplished by a thread wedging action. Rather, four series of three heavy annular lugs on the body and in the bonnet intermesh and lock the two parts together. Stress is evenly distributed and the full internal pressure acting against the bonnet is carried by the breech lugs. Pressure tightness is maintained by sealing the seam or joint with a seal weld, which can be chipped out to remove the bonnet, if necessary.

The combination of locking lugs and seal weld possesses a strength and structural stability not attainable in any type of construction that must depend on some form of gasket for pressure-tightness. *Leakage is impossible, and maintenance never required.* In effect, the Breech Lock with Seal Weld has all the advantages of the Strength Welded Bonnet design, plus the added advantage of easy disassembly and reassembly in the field.

NOTE THESE ADVANTAGES:

Eliminates bonnet-joint leakage under the most severe operating conditions. No maintenance required. ★ Provides for ready disassembly and reassembly in the field. ★ Bonnet-joint tightness unaffected by rapid temperature changes. ★ No sealing surfaces to become damaged by corrosion, oxidation, or in disassembly, and thus prevent reassembly of a pressure-tight joint. ★ No flanges, gaskets, or bolts that will require periodic maintenance attention. ★ Seal weld makes a leak-proof joint. ★ Compactness of design reduces weight and bulkiness. ★ Contour of body and bonnet lends itself to good foundry practice, resulting in sound, dense castings.

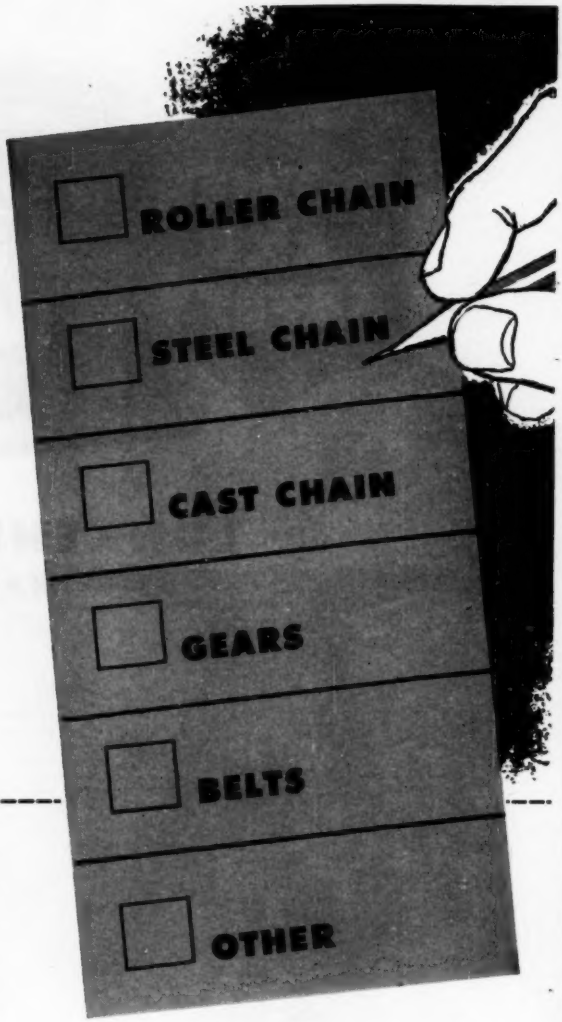
Write for your copy of "Lunkenheimer Cast Steels," a brochure describing basic research in alloys for high-pressure, high-temperature valves. Address: The Lunkenheimer Company, Box 360E, Cincinnati 14, Ohio.

STEEL • IRON • BRONZE

LUNKENHEIMER

THE ONE *Great* NAME IN VALVES

L-151-36



Have you made the right choice?

. . . if you're designing for lower cost!

Let's consider your power transmission equipment. You know that substantial savings in first cost . . . in operating cost . . . in overall cost can be realized through proper selection and application of power transmission equipment in your machines.

There is no one best method for all equipment. BUT there is a *right* answer to *each* machine for driving, timing and conveying. In the complete Chain Belt line, you can find an answer to the vast majority of applications. Because they are not handicapped by the limitations of a limited line, Rex Field Sales Engineers can help you select the exact type of chain that is right for your machines . . . for lower costs all along the line.

Perhaps you have been using a finished roller chain, yet speed and load conditions are such that a cast chain or double-pitch roller chain will operate equally well at lower initial costs.

Perhaps you have been using a cast chain, yet speed requirements demand a roller chain for efficient operation. It may be that your machine demands exact timing *throughout its life.* Only finished roller chain will answer this need.

Your equipment may be required to operate in dusty, dirty conditions. Chabelco Steel Chain can save you and your customers money here.

You may be using too heavy a chain for the service conditions under which your machine is to operate. The Rex Man will help you select the right chain that will do the job effectively at lower cost.

The complete Chain Belt line provides a chain to exactly suit virtually every application. In those instances where belts or gears may be better, the Rex Field Sales Engineer can tell you why you should use these mediums for best results.

Chain Belt Company OF MILWAUKEE

Baldwin-Rex Standard Roller Chain

Rex Cast Pintle Chain

Baldwin-Rex Double Pitch Roller Chain

Rex Chabelco Steel Chain

Rex TableTop® Conveyor Chain

Baldwin-Rex Leaf Chain

Your Rex Field Sales Engineer will be happy to consult with you regarding your application problems. He may be able to help you make substantial savings. Call or write your nearest Field Sales Office. Or, if you prefer, mail the coupon.

CHAIN BELT DISTRICT SALES OFFICES

Atlanta	Dallas	Los Angeles	Pittsburgh
Birmingham	Denver	Louisville	Portland
Boston	Detroit	Midland	St. Louis
Buffalo	Houston	Milwaukee	San Francisco
Chicago	Indianapolis	Minneapolis	Seattle
Cincinnati	Jacksonville	New York	Springfield
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Milwaukee 4, Wisconsin
Gentlemen:
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Please send me descriptive literature.
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Company.....*Dept.*.....
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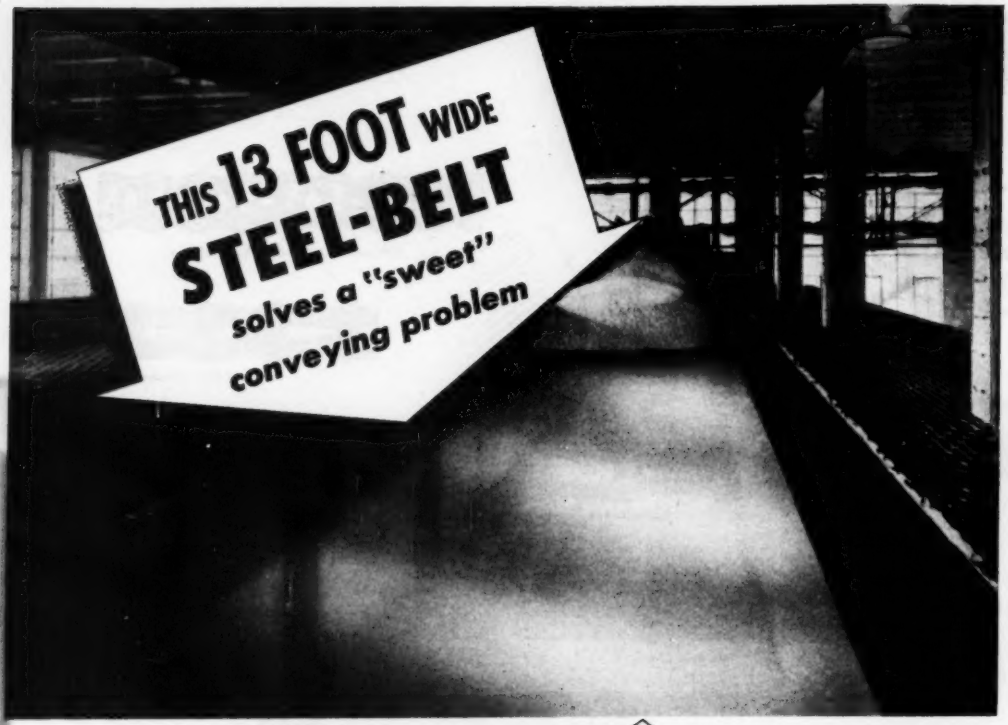


This is just one of a wide variety of conveying problems that a Sandvik conveyor can solve.

A Sandvik conveyor's special ability comes from its solid steel belt. This is a continuous moving band of flexible, cold-rolled steel.

Sandvik Steel-belt conveyors are available with carbon or stainless steel belts and are engineered to fit specific requirements.

They are furnished in any length. Standard widths range from 8" to 32" in 4" increments. For sizes over 32", belts can be longitudinally jointed to provide practically any width.

When required, the units can be equipped with water-bed cooling arrangements. Simple straight or V-shaped scrapers can be provided for discharging material at any point.

COMPLETE ENGINEERING SERVICE—Sandvik provides complete design, installation and follow-up services.

For further information or an engineering proposal for your conveying problem, contact Sandvik.

HERE ARE SOME PRODUCTS BEING SUCCESSFULLY HANDLED BY SANDVIK CONVEYORS

FOOD
Meat
Fish
Sugar
Cocoanut
Candy
Bakery Products
Fruits
Vegetables
Baby Foods
etc.

CHEMICALS
Tar
Salt
Pitch
Sodium Meta-Silicate
White Lead
Iron Sulphate
Grease
Synthetic Resin
Gelatin
Glue
Sulphur

CERAMICS
Brick
Tile
Cement
Clay

MINERALS
Ore
Coal

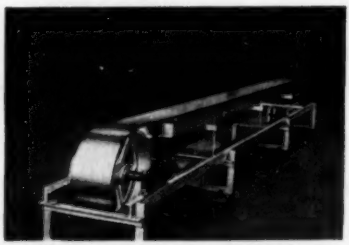
FOUNDRY MATERIALS, ETC.

SS-76

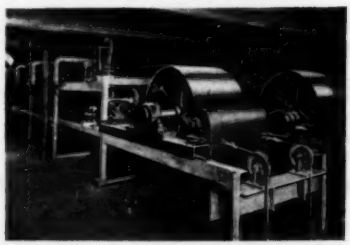
SANDVIK STEEL BELT CONVEYORS

SANDVIK STEEL, INC.
CONVEYOR DIVISION
111 Eighth Ave., New York 11, N. Y.
WAtkins 9-7180
Manufacturers of Steel-Belt Conveyors For Over 30 Years

ABOVE—This Sandvik conveyor uses a cold-rolled flat steel belt 13 feet wide for handling sugar. The problem of obtaining a conveying surface of this width was solved by longitudinally joining five separate Sandvik steel bands by a patented method. The conveyor performs the double function of conveying and storage en route.

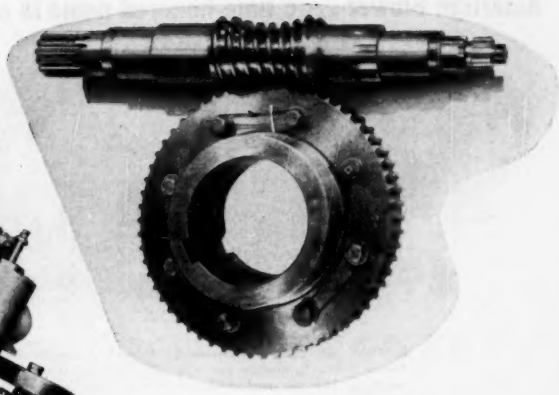


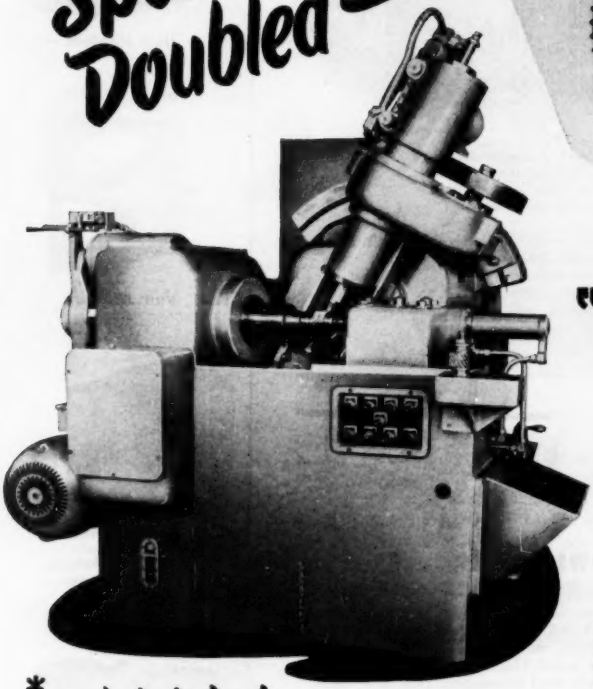
Sandvik cooling conveyor for processing fused glass.



Sandvik conveyors used in ovens for chemical processing.

Machine Speed Doubled*—





with "hydraulically" smooth CONE-DRIVE gears

ON the gear hobber illustrated here, high speed steel hobs are now run at CARBIDE SPEEDS—without sacrifice in hob life.

*and tripled

Impossible? Not when 'hydraulically' smooth DOUBLE-enveloping Cone-Drive gears are used. The main drive and index drive in this machine use Cone-Drive gears and are so smooth that the usual high-frequency vibrations caused by gearing are eliminated, to all practical purposes.

This vibration-free drive made it possible to run high speed steel hobs efficiently at several hundred feet per minute cutting speed instead of the usual 80 or 90.

That same 'hydraulic' smoothness can do wonders for your machines, too. You can obtain it either through designing standard double-enveloping Cone-Drive gears into your machines or by using complete Cone-Drive reducers instead of built-in gearing.

In addition to taking out vibrations, Cone-Drive Gears in this machine also made possible a large reduction in number of gears required in the drive.

We will be glad to study your designs for the simplest way to apply the advantages of DOUBLE-enveloping Cone-Drive gears to your equipment.

CONE-DRIVE GEARS
Division, Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

American Blower . . . a time-honored name in air handling

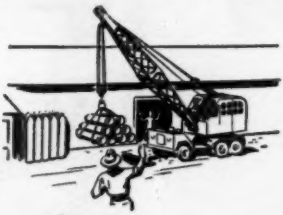
Buffalo, too, has a conveniently located American Blower Branch Office to provide you with data and equipment for air handling. You can reach American Blower in Buffalo by calling Washington 2668. In other cities, consult your phone book.

BETTER FABRICS . . .

Fine yarn filaments, strong plump fibers —these are the marks of a good textile mill. And, in many top mills, you'll find American Blower equipment helping in the control of inside temperature and humidity. For example, several of our large AHS Fans were ordered recently by an important Southern mill. The thing operators like about these fans is their non-overloading power characteristics and their remarkable efficiency over a wide range (which saves them money). May we help you with a similar problem?

HOSPITAL COMFORT . . .

A new Veterans' Hospital is going to be mighty comfortable—at least when it comes to ventilation. Reason—34 American Blower Sirocco Fans which were recently installed. These fans deliver more air per revolution than any other type of fan, operate at lower tip speeds, are unusually quiet, save power and require only a minimum of space for installation. For the best in air handling equipment, call American Blower.



POWER SAVER . . .

If you're concerned with power transmission, you'll want to know about our Gyrol Fluid Drives. Developed originally for use with mechanical draft fans, Gyrol Fluid Drives are today widely used in industry. They offer three important advantages—smoother acceleration, overload protection and substantial power savings. One company uses Fluid Drives on a crane that picks up acetylene tanks. Before they were installed, the tanks got such a violent swing from the quick start they would often damage building walls. Since using the Fluid Drives, they've had no trouble.

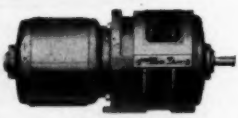
MAY WE SERVE YOU?

American Blower heating, cooling, drying, air conditioning and air handling equipment can do much toward improving comfort and efficiency in business. For data, phone or write our nearest branch office.

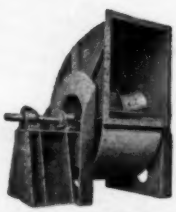
Unit Heaters

Ventura Fans

Air Conditioning Equipment



Gyrol Fluid Drives



Industrial Fans

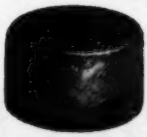
AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION

YOUR BEST BUY AMERICAN BLOWER AIR HANDLING EQUIPMENT

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS • DETROIT LUBRICATOR • KEWANEE BOILERS • ROSS HEATER • TONAWANDA IRON

Toothed Lock Washer: Prevents loss of stem nut due to vibration, thereby holding the handwheel securely.

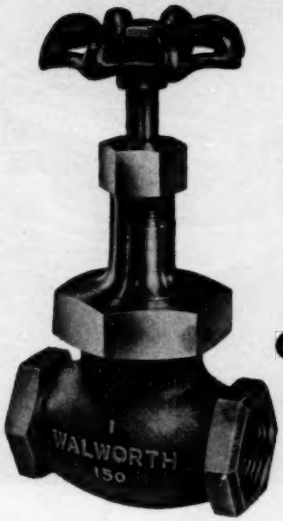
Newly Designed Handwheel: Air-cooled, finger grip handwheel affords sure grip even with greasy gloves.



Improved Packing: Molded packing of lubricated asbestos reinforced with copper wire. Suitable for practically every service. Valves can be repacked under pressure.

Hexagonal Union Bonnet Connection: Eliminates any chance of distortion or leakage even though valve is repeatedly taken apart and assembled.

WALWORTH



IMPROVED
No. 95
BRONZE
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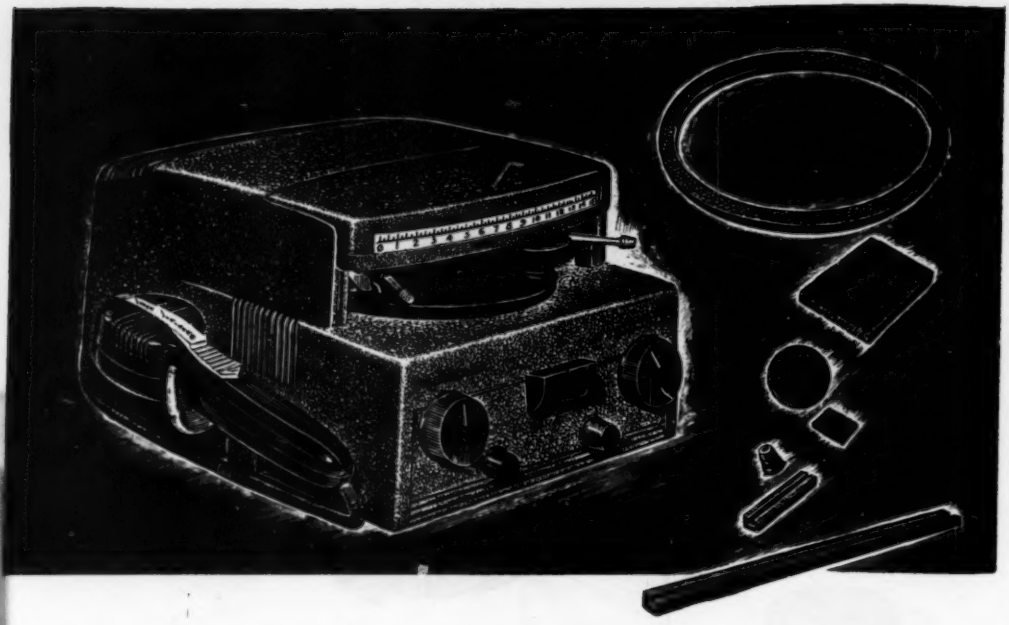

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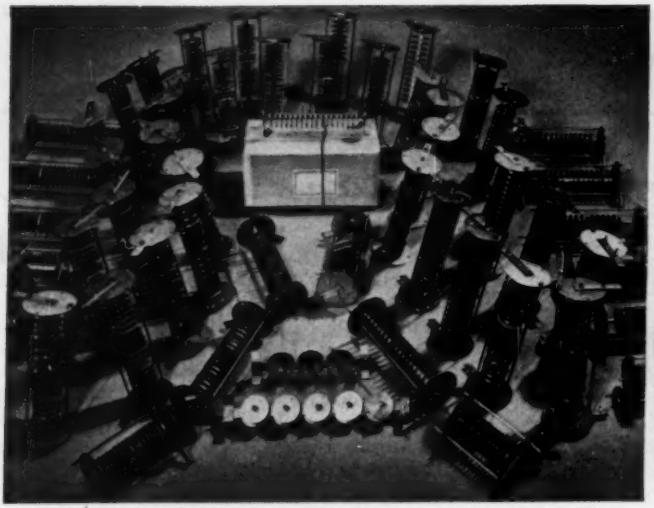

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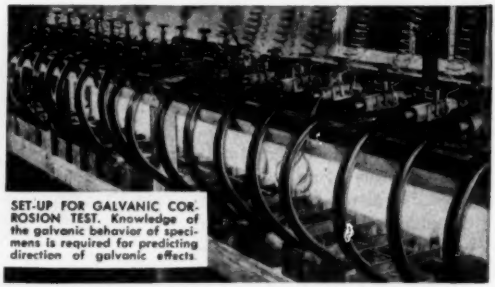

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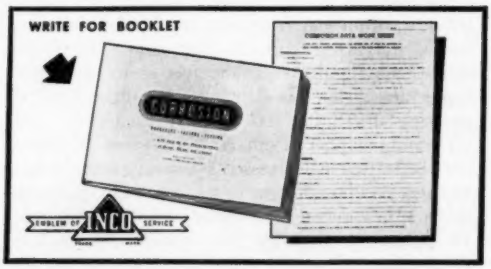

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 73 — NUMBER 11

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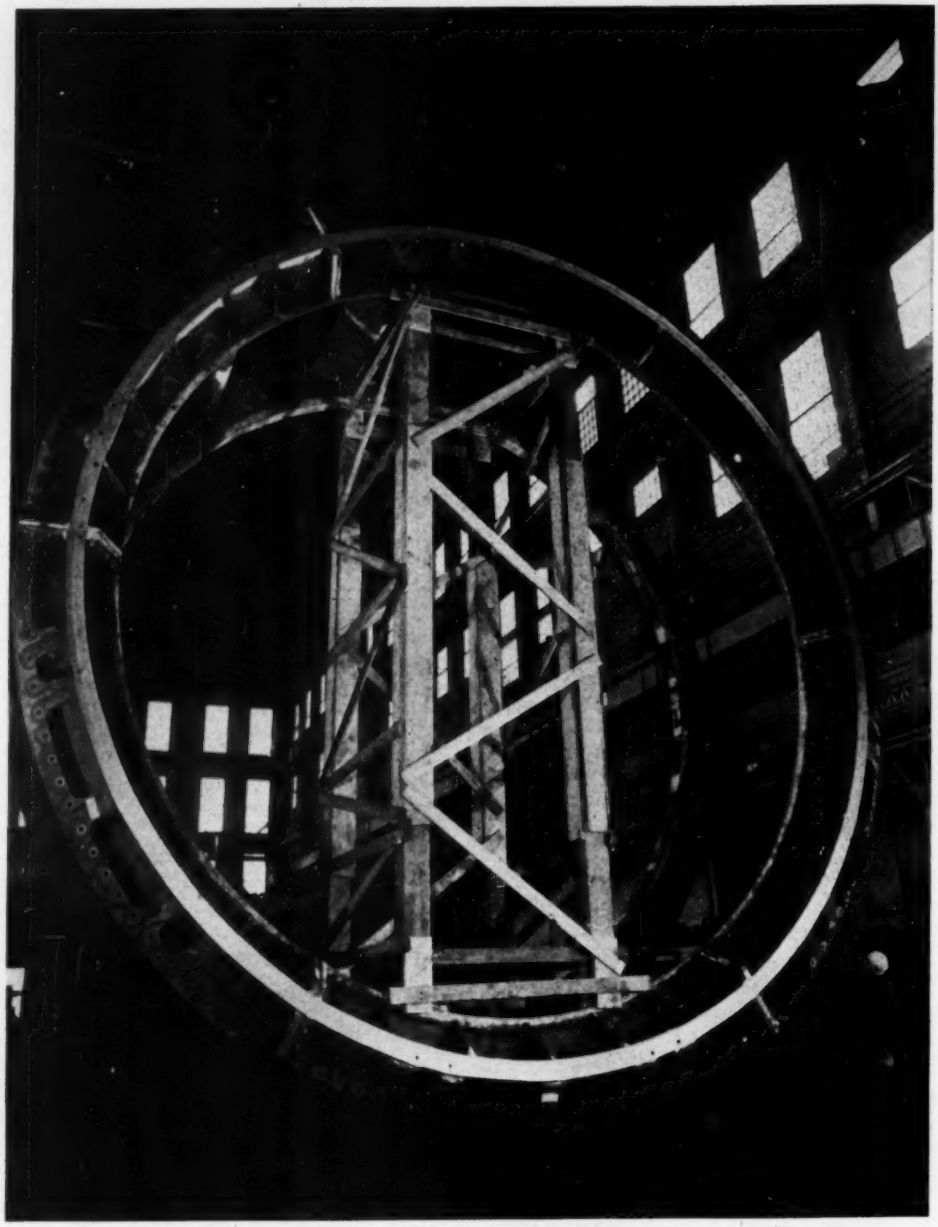

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VOLUME 73
No. 11

MECHANICAL ENGINEERING

NOVEMBER
1951

GEORGE A. STETSON, *Editor*

A Pattern of Utilization

IN AN attempt to arouse the industrialists and educators of the nation to the shortage of manpower in the engineering profession and the urgent need to utilize to the best advantage what resources are available, the Engineering Manpower Commission of the Engineers Joint Council staged a convocation at Pittsburgh, Pa., on September 28 in co-operation with the Engineers Society of Western Pennsylvania. A report of this convocation will be found in the news section of this issue.

A panel of four speakers laid the groundwork during the morning session for the question and answer period which followed after luncheon. A. C. Monteith, vice-president, Westinghouse Electric Corporation, opened the program with a discussion of the necessity for engineering development and for creating in the public mind an appreciation of the importance of engineering to our way of life. Dean S. C. Hollister of Cornell reviewed the situation in which the schools and engineering colleges find themselves in respect to present and future enrollment. M. H. Trytten, National Research Council, described the various governmental agencies and committees affecting technical manpower supply and utilization. And C. H. Brown, Eastman Kodak Company, summed up the points covered by the three previous speakers.

By this time, engineers should be fairly well aware of the facts about low enrollment in the high schools and engineering colleges and the reasons for the present shortage of graduate engineers. Dean Hollister, at the Pittsburgh convocation, summarized the situation succinctly and proposed a "pattern of utilization" to make the best of a bad situation. He said in closing his speech:

"At best it will not be possible to meet the need from the supply of graduates now expected from the colleges, because this supply will be less than half enough. Before the war, nearly 6 per cent of the boys graduating from high school entered engineering colleges. Now the rate has dropped to 4.8 per cent. About 10 per cent would be needed to meet peacetime civilian needs alone.

"The needs stated herein are in terms of the customary pattern of utilization of engineering graduates. Since the percentage of boys beginning engineering education is far below what is indicated as the need, and is declining, it is clear that the pattern of utilization of engineers must be greatly modified, if present necessary engineering work is to be accomplished with the limited number available.

"The following steps should be taken promptly by industry:

1 Use engineers *only* in jobs in which engineers are required.

2 Do not hold young engineers in "intern" positions longer than necessary to qualify them.

3 Move engineers to positions of maximum responsibility compatible with ability and experience.

4 Release engineers from positions not requiring engineering training.

"The following steps should be taken at once by the military services in the national interest:

1 Engineering specialists in critical engineering positions in the defense effort should not be called to duty regardless of reserve status.

2 Engineers should be assigned only to duties involving capacity use of their technical training and experience either through the draft, or through the reserves.

3 Reservists in enlisted ratings whose subsequent training qualifies them as engineers should not be called and used as enlisted personnel, but should be used only in assignments which must be filled *only* by an engineer.

4 Reserve officers whose subsequent training qualifies them as engineers should, if recalled, be assigned *only* to duty which requires engineering training."

New President of Stevens

THE inauguration on October 12 of Jess Harrison Davis as fourth president of the Stevens Institute of Technology marks an important milestone in the progress of engineering education.

Ties between the Institute and The American Society of Mechanical Engineers are strong and numerous and always have been so. Every president of Stevens has been a member of the Society, and two, Alexander C. Humphreys and Harvey N. Davis, served as ASME presidents. In addition, three graduates of Stevens, Frederick W. Taylor, '83, D. S. Jacobus, '84, and Paul Doty, '88, were presidents of the Society. The first president of ASME, Robert Henry Thurston, was professor of mechanical engineering at Stevens when the Society was formed; and the organization meeting of April 7, 1880, was held in the assembly hall at Stevens at the invitation of Dr. Henry Morton, first president of the Institute. A re-enactment of this famous meeting was a feature of the ASME Fiftieth Anniversary celebration in April, 1930.

Two of ASME's treasurers have been Stevens graduates, W. D. Ennis, '97, and K. W. Jappe, '09; and three other graduates, K. H. Condit, George E. Hulse, and Henry R. Kessler, have served on the ASME Council. Stevens has conferred honorary degrees on ten ASME

presidents, three vice-presidents, and many members; and the membership of the Society contains hundreds of Stevens men. The roster of ASME Committees and the indexes of ASME Transactions and other publications are rich in names of Stevens graduates and Stevens professors. Stevens was one of the first institutions to establish a Student Branch of ASME. Ten years older than the Society, this engineering school has indeed a history that has always been closely interwoven with that of ASME.

The fourth president of Stevens Institute of Technology comes to that institution from the presidency of Clarkson College of Technology at Potsdam, N. Y. Mr. Davis, a native of Ohio, was graduated from The Ohio State University in mechanical engineering in 1928. Five years later he received a master's degree from the same institution. Since graduation he has spent most of his life as a teacher and college administrator, but has also practiced engineering in a number of capacities. While still an undergraduate he spent a summer with the Fuller Lehigh Company, and immediately after graduation he served for approximately two years as a student engineer and assistant to the maintenance superintendent of the Ohio Bell Telephone Company and as a mechanical engineer with the Atmospheric Nitrogen Company.

In 1930 Mr. Davis started his teaching career at Clarkson as an instructor in mechanical engineering, where he was promoted successively to assistant and associate professorships. Heat power and experimental engineering were his special fields, and his duties included supervision of the college power plant and construction and remodeling of several college buildings. From 1944 to 1946 he was professor and head of the department of mechanical engineering at the Speed Scientific School.

Called back to Clarkson in 1946 as dean of administration, Mr. Davis became acting president in 1947 and president the following year. During this long period, he enriched his teaching techniques by maintaining constant contacts with engineering work off the campus. From time to time he was associated with the Alabama Power Company, American Locomotive Company, Foster-Wheeler Corporation, Hydraulic Controls, Inc., New York Air Brake Company, D. M. McBean, and DeWolf Furnace Corporation. While he was in Louisville he was active in the ASME Section there and chairman of the Louisville Advisory Committee on Smoke Abatement. He is registered as a professional engineer in Kentucky and New York State and is a member of the Kentucky Society of Professional Engineers. He holds membership in the American Society for Engineering Education and the American Society for Testing Materials. He has also served on committees of the Engineers' Council for Professional Development.

It is with this rich and varied experience in engineering practice, teaching, college administration, and engineering society activity that Mr. Davis takes over the presidency of Stevens. Commenting about this famous Institute, and about its first president, Henry Morton, and its first professor of mechanical engineering, R. H. Thurston, W. F. Durand writes in his biography of Thurston:

"The organization and opening of Stevens Institute formed a distinct departure from the trend of evolution of technical education in the United States. Edwin A. Stevens had left a sum of $600,000 to endow an 'Institution of Learning' and the trustees of this will decided that it should be an Institute of Technology and called as its first president, Dr. Henry Morton, then secretary of The Franklin Institute. Dr. Morton proposed narrowing the field to that of mechanical engineering; and thus was organized the first educational institution in the United States, measurably complete in itself, with attention centered on this particular field of engineering activity."

Morton, Humphreys, and Harvey N. Davis have set high standards of excellence for the Institute. Jess Harrison Davis is now the heir to this rich heritage and gives promise of carrying on the work of his predecessors with distinction and energy.

Engineering Societies Monographs

RECENT publication of "Hydraulic Transients," by George R. Rich, member ASME, serves as an opportunity to direct attention once again to the list of technical books issued as Engineering Societies Monographs and to review the status of that project.

About twenty years ago the need became apparent for a means by which engineering texts, too long to be acceptable to the engineering societies as papers for their transactions and too limited in treatment or in general interest to attract wide sale, could be made available to libraries and specialists without risk of financial loss. It was thought that such works would find a reasonably favorable market if they could be specially introduced under conditions that would not only guarantee their value and importance but also earmark them as belonging to a series of distinguished works.

Harrison W. Craver, then director of the Engineering Societies Library, and Martin M. Foss, representing the McGraw-Hill Book Company, devised such a means, and secured for it the approval and co-operation of the Founder Societies. As a result, the Engineering Societies Monographs Committee was organized. This committee of eight consists of two representatives of each of the Founder Societies with the director of the Engineering Societies Library acting as chairman. Under the scheme the McGraw-Hill Book Company underwrites the publication and sale of text that have been submitted to, and subsequently reviewed and recommended by the Committee. The books so published bear the imprint of the Engineering Societies Monographs Series. Arrangements between the Committee and the publisher include a provision whereby the Library receives modest royalties.

The list of monographs now includes twelve titles, two of which are second editions of works by Nadai and Timoshenko, originally published in 1931 and 1934, respectively. Royalties in excess of $8000 have been received by the Library. The names of Nadai, Wahl, Timoshenko, Goodier, Bakhmeteff, Tietjens, Baylis, Rouse, and Rich, who are the authors or co-authors of the books, are well known to engineers.

ENGINEERING ACHIEVEMENTS *in* SWITZERLAND *and* THEIR BACKGROUND

By FREDERICK OEDERLIN

MANAGING DIRECTOR, CHARGE OF ENGINEERING, SULZER BROTHERS, LTD, WINTERTHUR, SWITZERLAND. MEMBER ASME

IT IS both an honor and a pleasure to me to be granted this opportunity of delivering a Calvin W. Rice Lecture before this Society, and I should like to express to the President, the Secretary, and to the Council my deep appreciation of the courtesy shown me by their invitation. I knew Mr. Calvin Rice for a great many years, and in the course of our meetings in this country and of his several visits to Switzerland a friendship developed which was based on my side on the highest esteem for this man, who served your institution in an exemplary manner for almost 30 years. It is for this reason that my presence here today is, for me, not without a special personal significance.

When I was invited to address this meeting, I decided that instead of preparing a purely technical lecture on the specific achievements of Swiss mechanical engineering, I would attempt, while reviewing the most outstanding of these achievements, to show how they have come about; explaining them in the light of the given geographical and economic conditions of my country, of Swiss technical education, and of the specific qualifications of the Swiss engineer for tackling and mastering technical problems from the standpoints of research, development, design, and production. I felt that an address of this kind would probably be more interesting than concentration on a purely technical subject, and that you would perhaps welcome such a change in the general tenor of lectures delivered at this meeting.

GENERAL CONDITIONS

Switzerland, with her 4¾ million inhabitants, shut in on four sides by Italy, Austria, Germany, and France, has an area of about 16,000 square miles. From east to west the greatest length of the country is 226 miles; from north to south the greatest width is 137 miles. By comparison with American states, Switzerland is one third the size of the State of New York and twice that of Massachusetts. Nearly a quarter of her territory is unproductive for ordinary economic purposes owing to its mountainous character. Switzerland has no direct access to the sea. The nearest ports on the North Sea or the English Channel are 350 miles distant. The Mediterranean and Adriatic ports are nearer, but the nature of the intervening country is such that it presents great obstacles to transportation. In spite of nature's bounty in some respects, her treatment of Switzerland has been niggardly enough in others. Apart from stone, cement, and salt, the mineral resources of the country are negligible. Coal and iron, the fundamentals of modern industry, and steel products such as large forgings have to be imported. This dependence on foreign imports means that in times of economic stress, and even more so in times of war, the greatest difficulties are encountered in procuring raw materials and semifinished goods, as well as in monetary exchanges. The number of workers today employed by the Swiss mechanical-engineering industry is about 120,000, or 25 per cent of the factory workers of all groups. If social unrest and its attendant dangers are to be avoided, full employment must be found for these workers, and for this reason the supply of raw materials from abroad and the export of our products are of primordial importance for the social welfare of the country. This dependence on foreign countries for raw materials also imposes the further requirement that in times of abnormal economic conditions the mechanical-engineering works must have stocks in hand for a sufficiently long time, so that they can maintain production in spite of emergencies.

The struggle for existence which the Swiss have to put up in all sectors has been inherent in their situation since the Swiss Confederation was founded in 1291, and has thus come to be part of the national character. It first took serious form in the fourteenth-century wars for freedom from Austrian and later from Burgundian oppression. You will all know the story of William Tell, who remains as the medieval personification of the Swiss will to freedom. Even today, if you should be motoring on a narrow Swiss road and should want to overtake a farmer with his hay wagon, your only means of persuading him to pull in is to give him a gentle hint with your horn from close behind, and the gentler the better, for he will hardly make a move if you give him a brutal warning. It is not that he wishes on principle to barricade the road; but he does wish to be his own master . He is a born fighter for freedom and if he is to move his wagon from the middle of the road, he will do it of his own free will or not at all. This does not mean that he is not a good soldier; on the contrary, he will show the discipline necessary in military service because he knows that it is essential for the defense of his liberty. No other land dedicated itself so early to the ideals of democracy. On the other hand, nothing has come easily to the Swiss, and the constant struggle for existence and for independence has left a mark on them which still characterizes the national mentality and helps today to decide the attitude shown to their work.

The love of freedom in thought and action makes the Swiss averse to everything which smacks of dictatorship and collectivism. Though as a consequence of economic disturbances due, for instance, to wars in other countries, certain restrictive measures on economic and industrial co-operation are freely accepted, the Swiss are in principle against the intervention of the central government in the form of state control of social and economic life. The leaders of industry have a profound belief in free enterprise and individual creative work without state interference and, as a general rule, without its financial

Calvin W. Rice Lecture delivered at the Fall Meeting, Minneapolis, Minn., Sept. 26-28, 1951, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

help, since they prefer not to be bound and hampered by the conditions attached to such help. It is their belief that it has always been courageous private initiative, acting in the free play of competition, which has produced the most outstanding technical achievements feasible within the limits of sound economy. Switzerland also demonstrates the fact that mammoth corporations are not essential to great technical achievements.

All this implies a certain dislike of co-operative research and development within industry or under government sponsorship, as applied for instance in England between engineering companies working in the same fields and by the British Government. In addition, patent licensing plays an important part in the business policy of a number of Swiss engineering firms; it is essential that the patents and the "know-how" on which the license agreements are based should, if ever possible, be the exclusive property of the licensor. It is our belief that this uncompromising policy has made possible a great many of the outstanding engineering achievements which have secured for Switzerland a strong position on the markets of the world.

RESEARCH

The methods employed in research and development work are in keeping with this general policy. The bigger engineering firms have their own laboratories, well equipped with modern apparatus and staffed with first-class personnel. The research and development departments of a leading Swiss engineering firm with which I am myself connected will serve as an example of the lines on which such institutions are run. Those in charge of general policy in the firm are convinced that there are two important considerations on which the success of industrial research and development depends: firstly, that the organization created for this purpose should not be an isolated department, but should enjoy the standing and recognition of an integral part of the firm; and secondly, that it should collaborate closely on a teamwork basis with the designing and manufacturing departments of the works. This collaboration should be a natural result of an organization placed under the direction of the general technical management, which is thus able to co-ordinate all endeavors in the research and development fields with those of the technical, manufacturing, and sales branches, the whole effort being guided to suit general business policy.

Research activity is as a rule limited to practical ends; the fundamental scientific research is generally left to the Swiss Federal Institute of Technology or other similar institutions, with which the firm maintains regular contact and in some cases undertakes active collaboration. Fundamental research is only carried out inside the firm in exceptional cases, when problems are encountered that are of great importance from a business standpoint for the technical development of certain essential products and processes.

In our opinion it must not be forgotten that although science can point the way, there must be adequate scope for good common sense and intuition. In the industrial applications of technology, the simple and sound solution will always triumph over the complicated one. Finally it is the designer who, with natural talent and the means which science and experience have placed in his hands, backed by his knowledge of rational manufacturing methods, and with the help of the production department, must bring forth the crowning creative achievement.

As already mentioned, it is the belief of the leading Swiss industrialists that the costs of research and development should be borne as far as ever possible by industry itself, and a firm's expenditure for this purpose must therefore be commensurate with its own financial resources. Even so, the sums dedicated to this branch are often considerable in relation to turnover.

The smaller firms as a rule rely on the Industrial Research Division of the Federal Institute of Technology, an institution which is financed by the Federal Government, by the Cantons, and by industry. There are also a number of other institutions financed in the same way, one of them being entirely government supported, but it must be stated that their financial means are very limited by comparison with American standards. In recent times an endeavor has been made to open, in collaboration with but independently of the Federal Government, a national fund which would distribute annual subsidies to industry in general.

I think I am justified in saying that under these conditions, thanks to the readiness of industrial undertakings to finance research and development as a rule from their own resources, excellent results are being obtained at a minimum of expense.

THE SWISS AS A WORKER AND AN ENGINEER

I have already suggested that the character of the Swiss worker and engineer has an important bearing on Swiss engineering achievements. It will be worth while to go a little deeper into this question and to glance, at the same time, at Swiss education and professional-training methods.

The conditions which I described at the outset of this address have made the Swiss hard-working people. Among their valuable qualities as employees, whether in workshops or offices, are conscientiousness, reliability, and perseverance. The Swiss mechanical-engineering industry in general has a body of skilled machinists, fitters, and erectors at its disposal who still regard high-class work as a point of honor, taking a pride in their performance. At a time when the interest taken in work as well as the standards attained have in general noticeably declined in the wake of two wars on account of changes in social conditions, the attitude of our workers is a precious asset which has to be cultivated and preserved.

RELATIONS BETWEEN EMPLOYER AND EMPLOYEE

With regard to the relations of employers to employees, it will no doubt interest you to know that an antistrike agreement was reached between the Swiss mechanical-engineering and metal industries and the corresponding trade union as early as 1937, it being stipulated therein that any disputes arising should be settled as far as possible in the works themselves. This agreement covers general wage increases, overtime, and the introduction of methods calculated to affect the general conditions of work. The clauses of the agreement provide for the appointment of workers' committees wherever possible in the individual firms. If a dispute cannot be settled in the works or by the workers' representatives, it must be submitted to a mediatory instance which attempts to compose the differences in their early stages. Should no understanding be reached, the issue is brought before a higher instance which is required to arbitrate. This agreement applies irrespective of membership of a trade union. In the large mechanical-engineering works such membership does not exceed about 30 per cent of the total number of workmen. Each party to the agreement must deposit caution money, and in case of infringement of the terms of the agreement heavy fines may be imposed. It is laid down in an accompanying memorandum that the parties to the agreement will seek to foster the good relations prevailing between employers and employees and will not allow them to be hampered by the pursuance of aims dictated by trade-union policy. The agreement is expressly based on mutual trust and its stipulations must not be exploited for political or propagandistic purposes. Thanks to this understanding, the Swiss mechanical-engineering industry has—with the excep-

tion of a few minor incidents—been spared strikes of all kinds since 1937, that is to say, for 14 years. This social truce is an important prerequisite for the elimination of lost productive hours, quite apart from the fact that it serves the general interests of the country.

Swiss economic life is built up on export; the percentage of production for export in the major engineering works varies between 50 and 75 per cent of the total output. The average proportion of Switzerland's engineering exports to her total exports has varied in recent years between 33 and 43 per cent. Swiss industry can compete on world markets only if it can offer a product which has certain distinct technical advantages in design, workmanship, or economy. This means that Swiss products must have original features, and this in its turn calls for all possible efforts in the spheres of research, development, design, and workmanship. Great emphasis is laid on technical design rather than on highly developed production methods. In Switzerland the technical department as a rule carries more weight than the production department, while in this country the productive branch ranks as high as, if not higher than, the technical and sales branches.

Switzerland is a country which has not an adequate market of its own and for this reason mass production is an exception, particularly in large machinery. These conditions lead to a greater variety of products and types, with less standardization than customary in the United States. Great efforts are made, however, to find an intermediate solution between the two extremes by the rationalization of design and its adaptation to the most appropriate and cheapest manufacturing methods. It goes without saying that the general tendencies here outlined are not without their exceptions in the Swiss machinery industry.

I should like to turn now to the technical education and training provided for the young technologist. For it is clear that technical training, combined with the Swiss talent for engineering, plays an important part in the production of noteworthy achievements in this field.

EDUCATION

Switzerland's highly developed educational system is based on a long tradition. Almost every Swiss has attended a secondary school after six years of primary school. Prof. R. S. Edwards of the University of London, who studied Swiss technical education, states:

> The dominating characteristics of these schools (technical schools) are breadth and thoroughness. The underlying theme is that life is real and earnest and that education has a great deal to do with the practical job of making a living. As in a general way also in this sector there is rivalry between the different schools and the atmosphere tends to be individualist and competitive. The Swiss technical schools therefore have a good foundation on which to build.

There are two principal lines of technical education with two types of schools: firstly, the technical schools open to students without academic training or matriculation; and secondly, the technical universities, of which there are only two, the Swiss Federal Institute of Technology in Zurich, the official institution of the Federal Government, and the École d'Ingénieurs in Lausanne, a school under the control of the Canton of Vaud.

Students enter the technical schools of the first category about the age of 20 and finish about the age of 24. The qualification for entry is a practical training or apprenticeship of at least three years, and usually four. The standards for the selection of candidates are high, and severe examinations are set to insure that only the students best suited to the profession are chosen. Of 100 applicants, only about 20 finally emerge with a diploma. A good theoretical training is provided, with no unnecessary emphasis on the scientific side but considerable weight on designing. The requirements in the way of thoroughness and perseverance are high. The small classes of 16 to 20 pupils make it possible for the students to learn designing by personal contact with their teacher, who is himself an experienced designer. It is a great advantage to the students that they already have a grasp of their subject as a result of their three or four years of practical work. There are five such schools in Switzerland, each one showing individual and regional characteristics, so that industry can select its personnel accordingly. These schools are often taken as models by similar schools abroad, which are reorganized on the Swiss pattern.

Technicians trained in this way form an extremely valuable component of the technical staff of the mechanical-engineering industry. They can take up their work in a technical office on the very first day of their entry into the firm. The university man, with the exception of the pure scientist engaged in laboratory work, generally requires a fairly long period of introduction to his job. These schools, on the other hand, supply men with apprenticeship background and a theoretical and practical standard of knowledge enabling them to understand and appreciate the work of the scientist and technologist. They are able to see things from the point of view of the shop floor and thus form the designing stock that is of such value to Swiss mechanical engineering. At the same time they are highly appreciated by industry because they have a capacity for settling down to their job which is not so common among students from the technical universities.

While evening schools should perhaps be mentioned, they do not play a part of any importance; there are in fact only two of them in Switzerland.

The official technical university, the Swiss Federal Institute of Technology, does not aim at turning out professional specialists ready for immediate employment in industry, but at the establishment in the first few terms of a broad foundation of scientific and technical knowledge undivided by the specialization which the rapid development of modern technology might favor. Specialized branches of study are reserved for the later terms, and the student is then given a wide measure of freedom in the choice of his subjects.

In selecting men for entry into the university, special importance is attached to an adequate general education which can serve as a basis for professional study. Of the students entering the University, between 55 and 77 per cent, and on an average about 70 per cent, graduate with a diploma. As a rule, students have not done a previous apprenticeship. The practical training period of at least six months before entry and of at least three months after leaving, which are nowadays required, are just about sufficient to give the young men an idea of their future profession and to acquaint them with its atmosphere.

Special emphasis is also laid on the encouragement of independent thought and work. General knowledge and culture are not only maintained at the university, but if possible are deepened, and the attempt is made to awaken in the student an interest in the interconnection of the various branches of science, in the interplay of technical, economic, and social affairs, in the lasting values of Western culture, and the personal appraisal of cultural values.

ENGINEERING ACHIEVEMENTS

If I turn now to a review of Swiss mechanical-engineering achievements, the time at my disposal compels me to be brief, and I shall have to restrict myself to a general survey with a few technical data to characterize the achievements in question.

I would not wish these remarks to have any suggestion of publicity for the products of the Swiss mechanical-engineering industry, and for that reason I shall name no firms but shall keep to the neutral ground of general national accomplishment.

STEAM ENGINE

The origins of the Swiss mechanical-engineering industry can be traced back to the thirties of the last century. The textile industry, which still plays an important part in Swiss economic life, was the first to spring up, and was the starting point for the development of Swiss mechanical engineering. In this way the three oldest-established firms of the engineering industry came into being. One of the leading companies, for instance, was created in 1834, having developed from a brass and iron foundry which at first worked chiefly for the textile industry and subsequently widened the range of its products with the years. In 1865 this firm produced the first poppet-valve steam engine, with horizontal cylinder and valve drive from a lateral camshaft, which was to remain for many years the predominant world-famed design. This in its way was already a peak achievement of the young Swiss mechanical-engineering industry, which had received a decisive stimulus in this and other fields from pioneering work done in Great Britain. By 1900, horizontal steam engines of 6000 hp were being supplied, while steam pressures had reached inlet figures of about 285 and outlet figures of over 85 psi.

COMPRESSOR

When the young synthetics industry began, about the turn of the century, to build large plants for the industrial application of chemical and physical processes, the development of large compressors for air and gas was taken up as a sort of side line to the steam engine. Pressures at first reached 4000 psi, to rise after the introduction of George Claude's compression process to 15,000 psi, a pressure level which was reached in Switzerland by completely new methods as early as 1927. The new hypercompressors were made possible only by the use of hydraulic power transmission. Seven-stage compressors were employed, five of the stages being horizontal, while the two highest stages were of vertical design with plungers driven by oscillating oil columns. This design enabled machines to be constructed for deliveries of 5000 cu ft per min at 15,000 psi. Up to the present day the chemical industry in Europe has had no need for higher pressures, but this system would facilitate the access to still higher pressure ranges. Schemes have been under consideration in Switzerland for installations in the States with pressures up to 30,000 psi.

As a record in the domain of refrigerating machinery, a compressor plant erected in 1929 may be mentioned, which generates 40 million Btu per hr in a single unit with a gas volume of 10,000 cfm and an input of 3700 hp.

STEAM TURBINE

In the steam-turbine field, Switzerland received a powerful impulse from the authoritative and monumental work of Professor Stodola which appeared in 1903. Stodola occupied a chair at the Federal Institute of Technology, where I had the good fortune myself to study under his guidance. His work soon became the internationally accepted basis for the theory of modern steam-turbine construction. This branch was taken up about 1900 by four large Swiss works almost simultaneously, each one adopting a different system. One firm obtained a Parsons license and in 1901 built the first turbogenerator set in Europe for the Elberfeld Power Station, with an output of 5000 hp at 750 rpm. In 1904 a man-of-war was fitted, for the first time in Europe, with Swiss steam turbines. There followed in 1914 a plant of 7500 kw at 3000 rpm, and in 1919 one of 12,000 kw. These outputs, though modest by present-day standards, were at the time notable attainments. A superimposed turbine constructed in 1924 had an initial pressure of 700 psi at a temperature of 840 F. In the next year another superimposed turbine for a power station in Germany was built for 2550 psi at the same temperature. High-pressure and high-temperature steam plants with feedwater preheating and outputs up to 160,000 kw now developed rapidly. I shall not follow this development, however, beyond 1930, till which time the Swiss mechanical-engineering industry had done pioneer work on the steam turbine. From about this date onward, enormous progress has been made in this field in the United States, to which we Swiss engineers pay our highest tribute.

GAS TURBINE

The second world war imparted a powerful impetus to all branches of technical development in the belligerent countries, initiating a wave of progress by which Switzerland was only indirectly affected. A particularly swift advance was made in aviation, and this included in the United States the development of the gas turbine. Nonetheless, it may be noted here that the study of the gas turbine had been taken up in Switzerland, in collaboration with Holzwarth, as early as 1909, and that this led to an experimental unit in 1927. This turbine was of the explosion type and had an output of 2000 kw at a gas temperature of 1300 F. In the Holzwarth turbine the combustion gas flows periodically through water-cooled nozzles and drives an impulse wheel. The cooling water evaporates and is used, after superheating, in a steam turbine. This design was later abandoned in favor of the turbine with continuous combustion, which offered a higher efficiency. The first turbine used purely for power-station purposes in Switzerland was built in 1939 for the town of Neuchâtel and had an output of 4000 kw. The Swiss peak-load winter stations followed, with unit outputs of 13,000, 20,000, and 27,000 kw at gas temperatures of approximately 1200 F and thermal efficiencies of over 30 per cent. A plant on the closed system with an output of 12,500 kw was also supplied for a power station in Paris. In 1941 the first gas-turbine locomotive ever built, with an output of 2000 hp, was constructed for the Swiss Federal Railroads. In all, Swiss engineering companies have so far built gas-turbine plant totaling about 133,000 kw—in which one firm alone participates with about 75 per cent—making an average output per plant of 7000 kw with a maximum of 27,000 kw. According to the published data, all other countries have turned out industrial plants with about the same total kw, the average being 4000 kw per plant and the maximum output 15,000 kw.

STEAM GENERATION

In the steam-generating sector, Swiss firms have pioneered two new and original steam-generating units, the "Velox" and the "Monotube" boilers.

The Velox steam generator emerged in 1932 from the experiments of a leading Swiss firm with the Holzwarth gas turbine. It was found in this water-cooled gas turbine that at high velocities there was an unexpectedly high transmission of heat from the gas to the water-cooled walls. This observation led to the invention of the Velox steam generator with a combustion chamber supercharged by an axial compressor, small cross sections of flow, and high gas velocities in the boiler. A gas turbine utilizes the residual energy of the gas to drive the supercharging compressor. Space requirements are low, so that the boiler and turbines can be installed in the same room.

The Monotube steam generator, a forced-circulation boiler, made possible by highly developed welding technique, has only one structural element, namely, the tube. Material-consuming components such as drums and headers are absent. The tubes are used exclusively for heat transmission without any circulating pump, so that material requirements are kept to a minimum. This makes for freedom in the arrangement of the heating surfaces, favorable form of the boiler as a whole, and unrestricted adaptability to all firing systems. The feed-water problem has been solved by incorporating a special water separator which has proved its effectiveness in numerous large installations. The plants so far erected operate with live-steam temperatures up to 1020 F and pressures up to 2000 psi. Intermediate superheating is employed as a rule at pressures in excess of 1400 psi. The latest step in this line of development is the employment of a steam temperature of 1110 F, which was attained in an experimental plant for 2300 psi and has since led to the erection of an industrial installation.

INTERNAL-COMBUSTION ENGINE

In the Diesel field, it is noteworthy how a Swiss engineering firm has succeeded in obtaining a strong position on world markets by the quality of its products. This is brought out by the fact that at one time about 500,000 gross tons of merchant shipping, or 31 per cent of the total motorship tonnage of the world's mercantile marine, was equipped with Swiss-designed or Swiss-made marine Diesel engines. It may therefore be of interest to list some data on the developments and achievements in this branch:

1897 Experimental four-stroke Diesel engine built in collaboration with Rudolf Diesel. Output 20 bhp at 160 rpm.

1905 First direct-reversible two-stroke engine exhibited at the World's Fair in Milan. Output 100 bhp at 375 rpm.

1910 Biggest output ever attained in a single cylinder of a single-acting two-stroke engine, viz. 2000 bhp at 150 rpm.

1912 First large two-stroke engine for marine propulsion, twin-screw passenger ship *Monte Penedo*, output 1700 bhp at 160 rpm.

World's first Diesel locomotive. Direct transmission, V-engine, supercharged up to 170 psi, with air compressor for starting-up. Output 1600 bhp at 304 rpm and 62 miles per hour, built for the Prussian State Railroads.

As early as 1912 experiments were carried through on a four-stroke engine with supercharging up to an indicated mean effective pressure of 298 psi and a supercharging pressure of 50 psi. These experiments led to the present use of four-stroke supercharging.

1923 Quadruple-screw passenger ship *Aorangi*. Displacement 22,000 tons, output 12,850 bhp at 130 rpm. Still in operation after having covered about 2,200,000 miles.

1937 At that time the biggest Diesel-electric locomotive in the world with supercharged twelve-cylinder two-stroke engines. Total output 4350 bhp at 700 rpm.

1938 Triple-screw passenger ship *Oranje*. Total output 37,000 bhp at 145 rpm. Auxiliary Diesel engines totaling 9000 bhp. Biggest and fastest Diesel passenger vessel, attaining 26.5 knots in official trials.

1940 to 1946 Extensive development work on the supercharging of the two-stroke engine was carried out covering supercharging pressures from 14.2 to 71 psi, thus leading from normal to high supercharging and to the power-gas process by means of the free-piston gas turbine.

In the course of this development an experimental free-piston power-gas plant comprising three generators of 15 3/4 in. bore and 2 × 14 1/8 in. stroke, together with a gas turbine, was designed and tested. Its output was 6000 bhp at the turbine. Furthermore, in the course of this development, an eight-cylinder opposed-piston engine was built for an output of 2500 bhp at 950 rpm, with a mean effective pressure of 150 psi at a weight of 10 lb per hp.

HYDRAULIC MACHINERY

In a country where water power is widely used, it is only natural that results worthy of mention should have been achieved in the field of hydraulic machinery. Here the extreme working conditions are more notable than the size of the sets built.

Turbines. Our high mountains have given us the opportunity to develop plants for very high heads. Pelton turbines for heads up to nearly 6000 ft were built as much as 20 years ago.

Great efforts have been made in recent years to extend the field of application of the Francis turbine to include greater heads. This type of high-pressure turbine permits of much higher speeds than the Pelton turbine, the machines being smaller and cheaper at the same time. The turbines built for the Fionnay Power Station (Switzerland) are a typical example: with an output of 61,800 hp they run at 750 rpm against the remarkable head of 1500 ft which, as far as I know, is a world record.

For low-pressure installations with heads up to 200 ft the propeller or Kaplan turbine is adopted. Large Kaplan turbines are now being built for Aswân (Egypt), to give an output of 65,000 hp at a head of 102 ft, and for Donzère-Mondragon (Rhône Valley, France), to give an output of 70,000 hp at a head of 82 ft.

In so far as the size and output of the sets is concerned, the following particulars may be of interest. The figure of 100,000 hp per set was already exceeded in 1938. Before the war, Swiss industry supplied Francis turbines of 115,000 hp for a plant in Manchuria. At present, sets of 153,000 hp with a pressure of 360 ft at a speed of 187 rpm are under construction for the new plant at Bort in France.

Pumps. Swiss industry has similarly played a large part in the development of pump designs, which may be illustrated by the following examples from the history of hydraulic power storage. As far back as 1928, two hydraulic storage stations were erected in Germany, one of them being equipped with three pumps of 33,000 hp each, delivering 206,000 U. S. gpm against a head of 540 ft, and the other with four pumps of 27,000 hp each delivering 164,000 gpm against a head of 490 ft.

The maximum head for which a storage pump has been supplied so far is 3300 ft. This pump was built in 1941 for a plant in Switzerland; it has a rating of 7200 gpm at a speed of 1500 rpm and, as far as we know, the highest head ever attained in a storage pump.

The largest pump so far supplied by Swiss industry delivers 250,000 gpm against a head of 787 ft while running at 450 rpm and requiring 62,000 hp. It was built for the Providenza Plant in Italy. For many years this pump was the most powerful in the world, but has now been superseded by the U. S. Grand Coulee pumps, rated at 607,000 gpm at a head of 310 ft and a speed of 200 rpm, with a maximum input of 65,000 hp.

At the present time a project is being worked out for two pumps requiring about 80,000 hp each, which, if realized, will be the most powerful pumping sets in the world.

Although Switzerland produces no coal or oil and therefore has no big thermal power stations, she has taken a very active

part in the development of the design of high-lift, multistage, centrifugal boiler feed pumps. As early as 1929, units of this type were supplied for a pressure of 3625 psi for a Benson boiler installed in a power station in Belgium. We believe this pressure is still the highest ever attained.

TEXTILE MACHINERY

The Swiss textile-machine industry also depends on export for its existence, an existence which can thus only be assured by high technical performance.

An example of Swiss initiative and tenacity is the development of a revolutionary gripper-shuttle weaving machine which has found the recognition of the weaving industry. This machine reduces weaving costs per unit of material by using greater weaving width at higher speeds, with the possibility of weaving more than one width of cloth at a time. It is suitable for cotton, wool, linen, and artificial silk, and for both loose and close weaves.

The development of this weaving machine from existing primitive beginnings by a mechanical-engineering firm which had not previously designed or built looms of any kind, was an undertaking which extended over a period of many years. The perseverance of designers untroubled by specialized knowledge of conventional loom design was needed for the evolution and establishment of an innovation of this kind, which met with no interest on the part of conventional loom manufacturers.

The manufacture of the weaving machine in the United States has been taken up by a well-known machine-tool manufacturer.

Ring spinning machines for cotton, wool, and worsted yarns, modern looms, and knitting machines are also exported in considerable quantities, thanks to the high quality of their design and workmanship. Firms specializing in textile equipment such as dobbies, winding machines, and automatic tensile-testing machines for yarn also enjoy an excellent reputation abroad.

LIGHT ENGINEERING

It would lead too far to mention all the specialties in the domain of light mechanical engineering in which Swiss industry competes successfully with foreign production. One example among many others is furnished by the products of a Genevan firm building high-precision jig borers that are famous throughout the world.

CONCLUSION

The time at my disposal has been rather limited for the presentation of any broad survey of Swiss engineering achievements, especially as I have endeavored at the same time to convey to you a picture of the specific atmosphere and conditions in which such achievements have been and still are created. In doing this, I hope I have not entered the danger zone in which you might be under the impression that I have exaggerated Swiss engineering skill. Wherever I have mentioned a "biggest-in-the-world" achievement, I wish to apologize in advance in case anybody should find that my statement was not correct. I can assure you, however, that in this respect I have applied all the precautions at my disposal.

Gentlemen, we who have chosen technology as our profession speak the same language all over the world. We have to do with things which tell the truth, for we must keep in our work to the facts of science and to the laws of nature. If we were to disregard these laws, we should be doomed to failure. We also pursue our profession in a domain which knows no social distinctions, which exercises a uniting and reconciling influence, and stands above the tragic discord and turmoil of the modern world. May the words that I have today had the honor to address to you on engineering achievements in my country and their background be taken as a contribution to this line of thought, and as an expression of the bond that unites us all.

THE major problems confronting the nation are in the field of manpower or are closely related to manpower. It is also true that in the manpower field the problem is most acute and has its greatest impact for the age groups coinciding with the age of college attendance. This makes the present manpower crisis extraordinarily important for the future because the actions which are taken to solve these problems will have their major effects not so much now as in the future—five and ten and twenty or more years from now. It is not too much to state that an unwise resolution of these problems could fundamentally alter the nature of our civilization and dissipate its essential strength to the point where it will be extremely vulnerable in any future conflict.

The most important characteristic of the present situation is that there are no precedents for most of its features. 1951 is so different from any other year of decision that little help can be found by scrutinizing the past. We have had experience with the problems of both peace and war. But this is neither war nor peace but an uneasy and fluctuating admixture of both. The tempo of the present crisis can not even be measured because the initiative has not been with us. . . . In the meantime, we have determined both to maintain and preserve our civilization and to assume a posture of defense. We shall have both guns and butter. We shall do all of this with any sort of controls on our manpower confined to a very small proportion of our youth, the males of little more than a half dozen years apart in age at the maximum. And withal the motivation of national crisis is largely lacking. This small group of young men must furnish the armed force manpower supply and must furnish the hope of maintaining our supply of trained personnel in all categories, for the present and the future. This is much more of an era of training and preparation for conflict than a period of warfare. Therefore, for the present the mobilization of both manpower and production should be considered primarily a preparatory and training effort. . . .

The situation is so unprecedented and so difficult in its implication that the past has little to offer in the way of guidance. . . . Seldom has it been so necessary to discount the applicability of the methods of the past and to base design on the most cold-blooded analysis of the trends and events of the present. . . .

Complicating this whole situation is the fact that few appreciate the fundamental role of the United States in the previous two wars. . . . The superiority of American arms was primarily due to the productive capacity of the nation where that phrase includes the full technological gamut of operations beginning with the creative and inventive efforts of American scientists and inventors at work, the development phase where American industry prepares for a powerful and speedy job of reducing the technological concept to the finished design suitable for rapid and accurate reproduction on a mass basis, and finally the production phase in which the enormous production facilities of the country pour out in sufficient quantities military equipment to overwhelm the opposition. Any military planning for the present crisis or for future developments which do not consider this as perhaps the most important element in planning must therefore necessarily be seriously faulty.—M. H. Trythen, at the EJC Manpower Convocation, Pittsburgh, Pa., Sept. 28, 1951.

STORAGE *of* COAL

By W. L. LUNDY

KIMBERLY-CLARK CORPORATION, NEENAH, WIS. MEMBER ASME

THE coal-mining industry is one of the few great producers of consumer goods, which is distinguished by the fact that it does not have on hand a stock pile of its finished product.

It operates on a day-to-day basis with its reserves underground in an unprocessed condition.

This, together with other economic factors relating to the mining, transportation, and utilization of coal as a source of energy, necessitates the stock-piling of some 70 to 80 million tons by industrial users in order to insure a continuity of supply for their plants.

The industrial consumer of coal in the Great Lakes region, or on an inland waterway, takes advantage of the lower transportation costs during the open navigation season to provide a stock pile either at his plant or at a lake dock. This will provide fuel for his plant through the usual five to six-month period when the waterways are closed.

The proper storage of coal to avoid losses by fire and heating due to spontaneous combustion, windage, and weathering of the coal in storage presents a problem which has been solved by many of the larger users of coal over the years by cut and try methods.

Fundamentally there are four known substances which contribute most to the firing of coal in a storage pile. This firing of coal in a storage pile is called spontaneous combustion. Three of these substances are iron pyrites, water, and oxygen. These combine to form iron sulphate and sulphuric acid in an exothermic reaction, which acts as a pilot to start the carbon and hydrocarbon reactions with the oxygen in the coal or from the air, and under normal conditions will result in a loss in heating value of the coal in storage. Under more favorable conditions, accelerated oxidation of the combustible matter of the coal will take place with the result of visible burning.

It is apparent therefore in order to avoid either slow or accelerated oxidation, that the materials which are the cause of the trouble be eliminated in so far as possible.

The mining industry with its modern coal-cleaning and washing plants has advanced considerably during the past several years in the removal of at least a portion of the iron pyrites, or what is commonly known as sulphur, from their processed coal. Some coal seams are inherently low in sulphur and require little or no processing. It is logical therefore to select a coal for storage which has a comparatively low iron sulphide or iron pyrites content.

Water and oxygen are the other two substances which should be excluded from the coal storage pile in so far as is economically possible.

A fourth ingredient of coal, which has been found to effect its oxidation in storage are certain hydrocarbons.

These particular hydrocarbons are extractable from the coal with phenol, are easily oxidized, and give to the coal its coking characteristics.

It has been observed by many consumers of coal that freshly mined coals, when burned in stokers, have entirely different coking characteristics from coal from the same mine which has been burned following a period of storage. This same observation has been made when coal is used in coke ovens.

Those coals, therefore, which have a high phenol extraction index, or which possesses a comparatively strong coking property, will have the undesirable quality of poor storage characteristics. This is true even if the coal is comparatively low in sulphur content and possesses an inherent quality for low moisture absorption during storage.

PLACE OF STORAGE

The place for storage should be dry and well drained. Irregular contour of the ground surface permits pools of water to accumulate. Water is one of the substances which is to be avoided for the successful storage of the coal. The place of contact between the wet and dry coal in a storage pile has been found to be the starting point for many coal storage fires.

Irregular contour of the ground surface presents a further problem when the coal is reclaimed for use, since it is practically impossible to reclaim the coal without the inclusion of foreign material.

Wooden planks, posts, scrap lumber, and the like, should never be left on the surface where coal is to be stored, and it is also imperative that all foreign material, such as boards, excelsior, or straw sometimes used to cover holes in haulage equipment, be removed from the storage pile at the time of storing the coal, in case any of this material happens to be picked up by the crane bucket. These materials which are used for kindling of fires usually act the same way in a coal storage pile, and increase the tendency toward fires.

If at all possible, sufficient space should be left at the storage site so that coal from a developed hot spot can be moved and properly cooled. The only other alternative is to remove the coal from the hot spot and use it immediately.

Outdoor storage piles are naturally subjected to the weather, and attempts have been made to prepare the surface of the coal storage pile not only to shed rain water, but also to prevent the infiltration of air into the pile due to wind velocity.

METHODS OF PILING

Some coals, which have shown a tendency toward spontaneous combustion when piled loosely, can be stored successfully by close packing in order to force out occluded air resulting from the process of piling with a crane bucket. This close packing also tends to prevent the infiltration of air from windage.

Close packing can be accomplished either by the drag and scraper method with a bulldozer, or may be tamped with a heavy weight of comparatively large surface area.

The author at one time used the tamping method on an experimental pile of Indiana fourth vein $1^1/_2$-in. screening to determine its effectiveness in the prevention of coal storage fires.

This coal, when loosely piled in comparatively low piles, such as are possible with a locomotive crane, would fire and be a source of trouble and expense.

The site of the experimental pile was between two yard tracks

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approximately 50 ft apart permitting a pile of coal approximately 30 ft wide and 12 ft high to be stored.

The coal as unloaded by the locomotive crane from flat-bottom cars was placed in a layer three to four feet in depth over the storage area.

This layer of coal was then compressed by the lifting and dropping of a three-ton tamper with the locomotive crane. The tamper, which replaced the coal-unloading bucket during the tamping operation, was made up of channel and angle iron with a flat reinforced-concrete base approximately 30 ft sq.

Successive three-foot layers of loose coal were piled on the compressed coal forming the base, and the tamping operation was carried out on each layer until the final height was achieved. Incidentally, approximately 20 per cent more coal can be stored in the same space by this tamping method.

Temperature-test pipes with closed pointed ends were driven at intervals into the top of the pile, and the temperatures at the various points were taken over the period of coal storage.

There were no hot spots found and no fires developed in this storage pile at any time.

After many months of storage, a further experiment was conducted to determine the effect of storing freshly mined coal with the old coal.

A cut was made across the original pile of coal approximately 15 ft wide and the full depth of the pile. The coal removed was consumed by the plant.

Coal of the same size and from the same mine was then placed in the space using the same tamping method as used for the original pile. Within a period of a few weeks, hot spots developed at the junction of the new coal with the old, and necessitated the removal of the new coal.

As a general rule it is advisable to avoid the storage of freshly mined coal with old stored coal in order to prevent fires in storage piles.

One method of storing coal to prevent firing, which was in vogue several years ago, was known as airing or cooling. It consisted of turning over the pile of coal after it had been in storage for a few weeks in order to dissipate the heat generated in the pile immediately following the initial storage.

This method of coal storage was by no means very effective, even with other factors concerning the coal being favorable, and careful checking of pile temperatures had to be made so that hot spots could be excavated immediately. In the course of nine to twelve months of storage, it was found necessary to excavate several hot spots.

STORAGE-PILE SEALING AND CAPPING

A most interesting paper[1] has been published which covers the application of asphalt to the top surface of a 120,000-ton pile of mine-run coal at the Port Washington, Wis., plant in order to exclude air from the pile, and finally to smother fires which had started from spontaneous combustion by completely asphalting the sides of the pile.

Patching of the asphalt used on the sides of the pile was found to be necessary due to "bleeding" of the asphalt. Emulsified asphalt was first used, then a mastic of asphalt and coal, and finally fine coal was used.

The paper covers heat loss and general data of three large piles of coal stored for various lengths of time. Three projects are included: one with asphalt sealing, a second with fine coal covering, and a third with no fireproofing.

[1] "Prevention of Spontaneous Heating of Large Coal Piles," by M. K. Drewry, *Combustion*, vol. 8, 1937, pp. 28–32.

The effectiveness of sealing the storage pile with fine coal in preventing costly fires and reducing heat loss in the fuel during storage is clearly shown in the article.

The author's company has had 12 years' experience at one plant in storing approximately 40,000 tons of $\frac{3}{8} \times 0$-in Pocahontas screenings each year. This coal has a comparatively low sulphur content of 0.6 per cent, and the history of coal fires has been quite satisfactory, although temperature readings of 230 F were noted during the first year this kind of coal was stored. However, when these high-temperature spots were excavated, no fires were found.

The major difficulty in storing small-sized Pocahontas coal is windage loss. In order to keep this loss at a minimum as well as to keep moisture absorption low, the coal is oil-treated at the mine, and the pile capped over the entire surface with coal-gas tar. This capping process, no doubt, has contributed to the history of infrequent fires in the storage piles.

For the sealing of the pile with coal-gas tar, special equipment is used which consists of a gasoline engine with a d-c generator, tar supply tank, electric heaters, and a motor-driven pump with suitable rubber hose and nozzle, all mounted on a $1\frac{1}{2}$-ton truck.

The tar is heated to approximately 265 F and pumped through the rubber hose and nozzle with the pump which is rated at 200 gph at 150 psi. The tar is sprayed onto the coal-pile surface in four thin coats, which amounts to approximately 5 gal per 100 sq ft of surface. By spraying in thin coats, the cracks which develop are closed by the succeeding coats of tar.

RESUME OF RULES FOR STORAGE OF COAL

There are certain rules which should be followed by everyone who has to store coal for any reason.

These rules are as follows:

1 Select a coal, if economically feasible, which has a low pyrites content and a low phenol extraction number or index.

2 If possible, store uniformly sized coal. The nut, stove, egg, and lump sizes, when properly handled into storage, seldom require any attention in so far as storage fires are concerned.

3 Avoid breakage in handling and segregation of lumps and fines.

4 If nut and slack, or screening, are to be stored, the pile should be compressed by scraping and bulldozing, or tamping, especially if the coal most economically available has inherent properties which cause it to heat in storage. Such a pile of coal should be capped with coal-gas tar or other suitable materials to shed rain and to exclude air from windage.

5 Do not store near an external source of heat.

6 Have a well-drained site for the storage pile.

7 Remove all foreign materials, such as boards, straw, excelsior, from the storage pile.

8 Do not store freshly mined coal in contact with old coal.

9 Keep a weekly record of temperature at various locations in the pile, if previous experience so dictates, or a coal of unknown storage characteristics is being stored. If the temperature in some spot rises rapidly from one week to the next, or if there is visible evidence of internal heating, the hot spot should be removed as soon as possible.

10 If possible, space should be left at the storage site so that the coal from any hot spots which might develop can be excavated and moved to the space provided.

Developing TECHNICAL PERSONNEL *at* HAMMERMILL

By C. W. GUELCHER[1] and D. D. McKINNEY[2]

HAMMERMILL PAPER COMPANY, ERIE, PA

OUR company is naturally proud to have pioneered in personnel activities by establishing an Industrial Relations Department in 1918 which has since been divided into a Personnel Division and Labor Relations Division. Consequently, with such an early interest in the then new field of "personnel," the subject of "personnel development" has received attention through the years.

Special training opportunities for individual self-development have been created for our technically trained and technically minded men and women, as well as for other important personnel groups. Before describing these, however, it would be well to note the over-all objectives of our personnel program. This should result in an understanding of the relation of our personnel-development activities to other basic personnel functions.

OBJECTIVES OF PERSONNEL PROGRAM

To Develop Policies in the Best Interest of Personnel. Human-relations situations arising in our mill or office departments are normally referred to the Personnel Division. Here they are studied and policies in the best interest of all persons concerned are developed.

To Procure, Place, and Upgrade Competent People. This is accomplished through recruitment, interviewing, testing, and employee follow-up. This involves establishment of contacts with schools, colleges, public and private employment services, and so forth, as well as maintenance of continuing good relations with them. Modern techniques of interviewing and psychological testing are employed for both employment and upgrading of personnel.

To Develop Management and Personnel Groups. Comment on this objective will be covered separately, as this embraces the subject of this paper.

To Have a Well-Informed Personnel. People in any organization have a desire "to be a part" of that organization. It is this sense of "belonging" that helps to create job interest. The degree to which people develop a feeling of belonging is, to a great extent, determined by how well they are kept informed on company matters.

We try to maintain a well-informed organization through a monthly employees' news magazine and monthly newsletters from superintendents to their departmental personnel.

Matters of a semiconfidential nature are covered in letters from members of top management, mailed to employees' homes as the occasion demands.

Up-to-the-minute announcements are posted on departmental bulletin boards, and also covered in special meetings called by department heads.

To Promote Job Satisfaction, Security, and Welfare. The following types of activities are related to this objective: Wage and salary administration, service recognition, group insurance, Blue Cross insurance, workmen's compensation, employee Christmas parties, employee loans, housing and transportation, suggestion system, pension plan, and employee recreational clubs.

To Maintain Safe Conditions and a Healthy Personnel. This is primarily the responsibility of the Medical and Safety Departments. Employees are given physical examinations prior to employment and prior to job transfers. Men on certain jobs, where inability to perform their duties properly might result in danger to others, are given periodic examinations. All persons 65 years of age and over are given an annual physical examination.

Important to fulfilling this objective is our safety-engineering program designed to provide protective equipment where necessary and keep our people safety-minded. Effort is also made to adhere to high standards in providing and maintaining rest rooms, locker rooms, and sanitary facilities.

To Maintain and Improve Our Standing With the Public. Members of our management serve on the boards of many civic and social-service organizations, and in-plant campaigns for worthy causes are conducted throughout the organization. The company has representation in all of the various professional organizations connected with our industry. Matters of community interest pertaining to the company are given proper newspaper publicity in an effort to keep the community informed.

To Integrate the Personnel Program Through Research and Records. In one respect, this is an evaluation of all the effort put into the other seven objectives. For example, personnel records are analyzed with a view toward discovering reasons for high turnover or excessive absenteeism, in order that proper action might be taken to correct any adverse situation. Studies of employees by age groups and length of service are also conducted to be alert to changes in characteristics of personnel.

MANAGEMENT AND PERSONNEL GROUPS

While training and other personnel development activities are specifically designed to meet primarily the third objective, it can be appreciated readily that these activities help to fulfill each of the other objectives.

Training Activities. As mentioned previously, our subject is related to self-development opportunities provided under the third objective, To Develop Management and Personnel Groups. We strive to meet this objective through the following training activities:

Orientation training for new employees
Three-year pulp and paper course
Management breakfast meetings
Apprenticeship course for trades in maintenance
Organization and operations training
Supervisory training
Work-simplification training
Sales training
Mill and office on-the-job training

[1] Assistant Personnel Director.
[2] Psychological Test Technician.

Contributed by the Education Committee and presented at the Semi-Annual Meeting, Toronto, Ont., Can., June 11–15, 1951, of The American Society of Mechanical Engineers.

Opportunities for Technical Training. The manufacture of paper requires many involved technical processes. Therefore, in addition to the usual technical "staff" positions, we require technically trained people in many "operating" positions, both supervisory and nonsupervisory.

Those in technical positions such as engineers, chemists, lab technicians, certain supervisors, and other key employees, as well as candidates for these positions, find special opportunity for gain of personal knowledge and development in our three-year Pulp and Paper Course, Management Meetings, Organization and Operations Training, Supervisory Training, and Work-Simplification Conference Training. Therefore we shall confine the remainder of this discussion to these five programs of personnel development.

PULP AND PAPER COURSE

The first opportunity extended to technically minded employees is the three-year Pulp and Paper Course.

The basic first year consists of 28 informative sessions, covering all phases of our operations from the cutting of wood in the forest to the shipping of finished paper to customers. The 28 weekly sessions are of one-hour duration, followed by a 30-minute question-and-answer period. Heads of various departments serve as discussion leaders.

Enrollment in the first year of the course is open to any member of the organization, but completion of the first year is a necessary requisite to enrollment in the second and third years.

The purpose of the comprehensive first year is to give a broad general idea of all operations, and to serve as a basis for the second and third years.

Second and third-year classes are of three-hours duration and are also held weekly. However, as in the first year, it is necessary to repeat each subject the following week to permit shift workers to attend the sessions.

In the second year, students are given basic training in the following subjects: mathematics, electricity, hydraulics, and chemistry, with emphasis on their application to the manufacture of pulp and paper.

The third year, given at a higher technical level, covers the entire manufacturing process.

Included in the curriculum for the course are the following subjects:

Manufacture of pulp
- Wood
- Various pulping processes
- Sulphite cooking processes
- Screening
- Bleaching
- Pulp testing

Manufacture of paper

Beating:
- Paper characteristics
- Beating and refining
- Filler, loading, and sizing
- Coloring

Paper machines:
- Stock flow on paper machines
- Regulating box to fourdrinier
- Auxiliary equipment and press sections
- Driers and size press; air handling
- Calender, reel, winder, paper-machine drives
- Paper testing
- Duties of crew; operating variables; broke variables

Finishing:
- Conventional processing; Cutters (sorting, counting, inspection); trimmers; sealing (packing and labeling); warehousing; methods and costs
- Special processing; supercalenders; rewinders; safety paper; embossing; converting
- Special converting; Air drier; pasting; coating, waxing; other possible finishing operations

Visit to and study of a printing plant

Classroom instruction is supplemented by visits to the mill for observation of each process under discussion.

Enrollment in the Pulp and Paper Course (particularly the basic first year) includes a broad cross section of our personnel, in addition to technical people. Thus technical employees have an opportunity for firsthand discussion of production problems with practical operating personnel.

Students attending 80 per cent of the first-year sessions are presented with a certificate for completion of the one-year basic course. A certificate for completion of the third year is presented to those students who attend over 80 per cent of the sessions and who also obtain a satisfactory rating by the instructors.

MANAGEMENT BREAKFAST MEETINGS

Unique in our personnel development program are management breakfast meetings, held quarterly on Sunday mornings. These meetings are attended by all members of management from first-line supervision up, approximately 250 in number. In addition to officers, department heads, assistant department heads, section heads, and mill supervisors, they are attended by technical and sales personnel. In these meetings top management reports to the entire management team on matters of company-wide importance.

Usually included in the program is a review of market conditions and a forecast of sales for the coming 6 months. Other subjects discussed include such matters as new-product development, contemplated equipment changes and expansion plans, revisions in labor law, manufacturing problems, and similar subjects. The purpose of these meetings is to keep the management group abreast of all developments at the management level.

ORGANIZATION AND OPERATIONS TRAINING

In our organization and operations training, carefully selected trainees follow a predetermined schedule of work, observation, and study in all major departments of the mill and office. Schedules are tailor-made to meet the needs of the individual, and vary in length from 1 to 12 months of full-time training.

The progress of each man in the program is followed closely by the Personnel Division through weekly consultations with the trainees. In addition, "evaluation" reports, which are prepared by department heads, are submitted to the Personnel Division.

While some men in this program are being trained for specific technical, sales, or other management positions, decision on placement of the remainder is made during the training period. Thus we have a growing pool of well-trained men upon which to draw.

To qualify for entrance into organization and operations training, a man must have been graduated from college or have the equivalent in practical experience. In addition he must successfully meet diagnostic interviewing and psychological testing requirements. Technical ability must be supplemented by practical judgment and physical and emotional health.

(*Continued on page 891*)

DIRECT-CHILL CASTING *of* ALUMINUM INGOTS

By W. E. KING

CHIEF WORKS METALLURGIST, FABRICATING DIVISION, ALUMINUM COMPANY OF AMERICA, MASSENA, N. Y.

THE development of the "direct-chill" ingot-casting process stands out as an important milestone in the history of the aluminum industry. Following original intensive work at Alcoa's Massena, N. Y., works in 1934, the process was adopted rapidly throughout the plants of the company. By 1936 many casting units were producing direct-chill ingots for rolling, forging, and extrusion; and the output could be measured in units of millions of pounds per month. By 1938 the process held a dominant position in the aluminum-alloy field in the United States. During World War II, the huge quantities of aluminum-alloy ingots required were produced by this process. It appears certain that the direct-chill process was the first continuous casting method of major commercial importance either in this country or abroad.

Discussion of the direct-chill process before this Society may tend to emphasize the mechanical side of the operation. Actually, ingot casting is primarily a metallurgical event of basic importance in the history of the fabrication of any metal product. The structure of the ingot will be determined by the casting method; and this structure will govern the behavior of the ingot during metalworking operations as well as the quality of the fabricated product. The direct-chill ingot-casting development was based on important metallurgical requirements. Some knowledge of ingot types available in 1934, and their metallurgical shortcomings is necessary as a background to a discussion of the direct-chill process.

TYPES OF INGOTS

Before this development, by far the larger proportion of aluminum and aluminum-alloy ingots was produced by some variation of cold-mold ingot casting. Here the molten metal is poured into a thick iron mold held at a relatively low temperature, and solidification occurs by transfer of heat to and through the mold. In aluminum ingot casting, the control of aluminum-oxide inclusions and of shrinkage porosity always has been of great importance. Therefore the two cold-mold processes of most importance both involved careful filling of the mold at a relatively slow rate to minimize metal agitation and to favor progressive solidification of the ingot from bottom to top. In the "tilt-mold" method, which is still used today for certain small ingots, the mold was tilted nearly to the horizontal position and metal was carefully introduced as the mold was rotated slowly to the vertical position. In the Zublin method for casting large ingots for plate and sheet rolling, the metal was introduced by means of a nearly horizontal trough extending through an open edge of the mold which was closed by an appropriate mechanism as the mold was lowered vertically.

Cold-mold ingots of small size could be used in the simpler aluminum alloys; but when developments after the first World War required the production of large ingots in the complex heat-treatable alloys, it was found that this ingot type was far from satisfactory. Ingots tended to crack severely during hot-rolling or forging, contained a large amount of porosity, and showed considerable segregation of the alloying constituents. Studies of casting conditions and of ingot structures indicated clearly that the main drawback to the process was the slow rate of heat removal which became more important as ingot size increased.

Another casting method, called the "water-dipped-ingot" process, had been introduced before 1930.[1] Large ingots of considerably higher quality than those obtainable by cold-mold methods were cast by this process. An iron mold that had been heated to a temperature above the melting point of aluminum was filled with molten metal. This mold was then lowered slowly at a controlled rate through a heating chamber into a heavy water spray. This resulted in progressive bottom-to-top solidification, a narrower freezing zone, and a marked reduction in porosity and constituent segregation. However, the general rate of solidification was still quite slow, and, as a consequence, the constituent structure in complex alloys was coarse and hot-working characteristics far from satisfactory.

In 1934 the tilt-mold method was used for nearly all small rolling ingots and for all extrusion ingots; the Zublin process for large sheet and plate ingots; and the water-dipped-ingot process for large ingots for rod and bar rolling and for forging. Large aluminum-alloy ingots of improved quality were needed in all of these fields, but the story behind the development of the direct-chill process centers around the situation at the Massena Works of the author's company. At this plant, a 38-in. two-high reversing blooming mill and a 26-in. structural mill had been built in 1929. Ingots in such sizes as 12 in. × 12 in. and 18 in. × 18 in. were required, and it was found that the inferior structure of ingots of available types led to serious difficulties during fabrication, and to deficiencies in the quality of products fabricated in this plant. These included large rolled structural shapes, rod and bar, and forging stock.

The main objection to all available ingot types seemed to come from the slow rate of heat extraction. This was caused by the insulating effect of the air gap between ingot and mold that resulted from the original solidification and contraction of the ingot surface. Some means had to be developed to eliminate this obstruction to heat flow. A solution for this problem was found by removing the mold after a shell sufficiently strong to support the molten metal had frozen, and then spraying water directly on the ingot surface. The best way to do this was by a downward movement of the ingot in the mold. Such a procedure became possible if the mold was smooth and efficiently cooled so that shrinkage took place immediately on contact with the mold and thus gave the necessary clearance for slippage. It was found also that the metal depth in the mold during casting should be shallow so that the ingot surface

Contributed by the Metals Engineering Division and presented at the Annual Meeting, New York, N. Y., November 26–December 1, 1950, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[1] U. S. Patents 1,777,657, 1,777,658, 1,777,659, issued to Stay and Holshauer.

could be cooled directly as soon as possible and thereby provide a narrow freezing zone and rapid heat extraction from the ingot center.

DEVELOPMENT OF DIRECT-CHILL PROCESS

The direct-chill process, as developed at Massena in 1934,[2] is shown diagrammatically in Fig. 1. This shows a thin mold made of a high-conductivity metal that is open both at the top

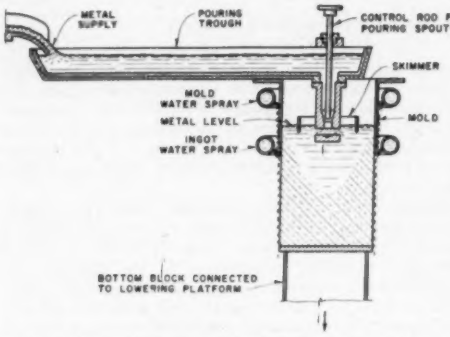

FIG. 1 DIAGRAM SHOWING BASIC DETAILS OF DIRECT-CHILL INGOT-CASTING PROCESS

and bottom. While the bottom of the mold is closed temporarily by means of a metal bottom-block, molten metal is introduced into the mold through a pouring spout. The bottom-block and solidifying ingot are withdrawn from the mold at a constant rate and the introduction of metal controlled so as to maintain a constant depth of metal in the mold. The outer shell of the ingot is frozen by transfer of heat through the mold to cooling water, and the entire central portion by direct flow of heat through this shell and to an envelope of water that flows down the exposed surfaces of the ingot as it emerges from the mold. This direct application of water to the ingot surface eliminates the insulating effect of the air gap between ingot and mold and gives a much more rapid rate of solidification and a narrower freezing zone than was possible by processes used previously.

Because this direct application of water to the ingot surface was the most important feature of the development, the name direct-chill or "D-C" was selected by the company for the process and ingot.

The chief difficulty encountered in the first trials of the process using a 12-in. × 12-in. mold was tearing of the ingot surface. After a few more ingots had been cast, it was discovered that lubrication of the inside surfaces of the mold eliminated this difficulty. Since that time molds have been lubricated, generally with an oil or grease, in all D-C casting.

It was soon evident that a very high rate of cooling had been achieved in all parts of the ingot, including the all-important central portion. The entire ingot showed a very fine uniformly distributed constituent structure. The ingot was sound and had a fine equiaxed grain structure. Segregation was less than had been found in any other type of ingot. The hot-working characteristics were excellent, with the center sufficiently strong to resist the internal forces that had caused rupturing in other types of ingots during hot rolling.

Figs. 2 and 3 show the heterogeneous structure of high-strength heat-treatable aluminum alloys, and the remarkable decrease in size of the constituent network that was achieved by the rapid cooling of the direct-chill process. Fig. 2 shows the microstructure at the center of the best ingot previously available, the water-dipped ingot; and Fig. 3, the structure at the center of a D-C ingot of the same size and at the same magnification. In these figures, particular attention should be given to the relative size of typical areas of insoluble constituent that are encircled and indicated by arrows. The refinement of structure is shown even more clearly in Figs. 4 and 5 which are photomicrographs at the same magnification, of 6-in. × 6-in. blooms rolled from the ingots in Figs. 2 and 3. It may be noted, incidentally, that considerable soluble constituent present in the network in Figs. 2 and 3 was dissolved during ingot

[2] U. S. Patent 2,301,027, issued to W. T. Ennor.

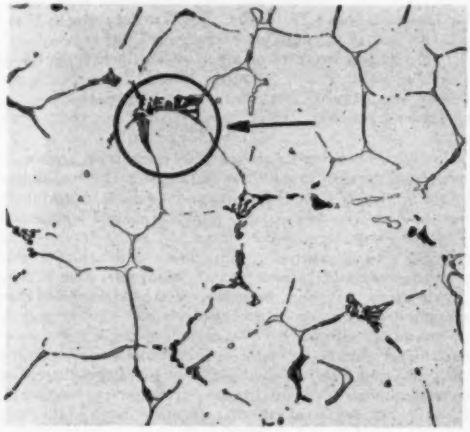

FIG. 2 PHOTOMICROGRAPH SHOWING MICROSTRUCTURE AT CENTER OF TYPICAL 17S WATER-DIPPED INGOT
(A typical area of insoluble constituent is encircled and indicated with an arrow; ×100.)

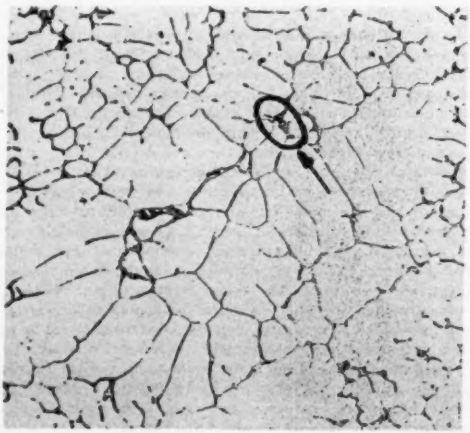

FIG. 3 PHOTOGRAPH SHOWING MICROSTRUCTURE AT CENTER OF TYPICAL 17S DIRECT-CHILLED INGOT OF SAME SIZE AS IN FIG. 1
A typical area of insoluble constituent is encircled and indicated with an arrow for comparison with that shown in Fig. 1; ×100.)

preheating and is not found in Figs. 4 and 5. All four figures are of the heat-treatable aluminum alloy 17S.

By the end of the year 1935 the D-C process had been used in the casting of many ingot sizes and shapes. These included round extrusion ingots, large rectangular ingots for sheet and plate rolling, and hollow round ingots for the extrusion of tube blooms. Casting of the latter ingots involved the use of a tapered water-jacketed core supported in the center of the mold. The core was approximately as long as the mold, and water was applied directly to the internal as well as the external ingot surface below the mold and core.

ADVANTAGES OF DIRECT-CHILL PROCESS

Commercial experience with the many ingot types and sizes demonstrated clearly that the direct-chill process had many advantages in addition to the excellent ingot structure. The author's company has found it to be cheaper than any other method so far tried when used on a semicontinuous basis in multiples of up to about 14 ingots at a time.

Mold cost is much lower than in the water-dipped process. Semicontinuous D-C casting equipment is more complicated than that required for the cold-mold types, because it is more highly mechanized, but maintenance costs are reasonably low. Desired ingot weights are, of course, easily obtained by changing the ingot length. By building mold and spray assemblies as separate units, ingot sizes and shapes may be changed easily.

Another important advantage of this method of ingot casting is that it allows a satisfactory metal transfer into the mold. As the mold can be very shallow with the free metal surface near the top, the vertical drop during the transfer is small. This is particularly important in aluminum because the surface of the molten metal is always covered with a thin film of oxide which is easily broken and mixed into the metal if there is excessive agitation. Where the mold length is determined by the ingot length required, as in the cold-mold or water-dipped process, the transfer problem is much more difficult.

As a result of the progressive bottom-to-top freezing of the ingot, the head is almost level and contains only a negligible shrinkage cavity in the center. In the tilt-mold process, on the other hand, it is necessary to add molten metal slowly over a relatively long period of time in order to prevent a deep pipe in the top of the ingot.

INTERNAL CRACKING AND LIQUATION

The greatest disadvantage of the process is internal cracking caused by the high internal stresses that result from the rapid cooling. Under some conditions, the cracking extends to the surface during casting, and ingots have even fallen into two or more pieces shortly after being removed from the casting unit. Ingot shape is an important factor, the rectangular shape of sheet ingots with a high width-to-thickness ratio being the best, and a round probably worse than a square shape. In general, a variation, in the direction of a sharper chill, of any factor such as lowering rate, metal temperature, metal depth in the mold, water temperature, and water volume is also in the direction of a greater tendency toward splitting. Alloy type is important, certain alloys like 75S, 11S, 61S, and very high-purity aluminum giving more trouble than others such as 18S, 2S, 3S, 25S, and 52S. By careful control of the important factors just mentioned, it is possible today to keep the loss from this defect to 1 or 2 per cent or less.

A second disadvantage is the liquation commonly found on the surface of these ingots. Since this liquation layer is relatively brittle, it is necessary to scalp the surface of ingots either before or after the initial hot-working operation.

FIG. 4 PHOTOMICROGRAPH SHOWING STRUCTURE OF 6-IN. × 6-IN. BLOOMS ROLLED FROM WATER-DIPPED INGOT OF FIG. 2; ×100

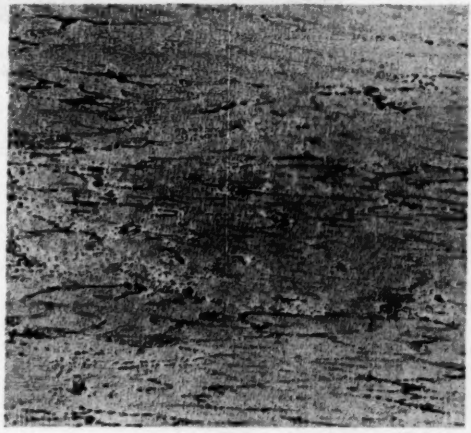

FIG. 5 PHOTOMICROGRAPH SHOWING STRUCTURE OF 6-IN. × 6-IN. BLOOMS ROLLED FROM DIRECT-CHILLED INGOT OF FIG. 3

(It may be noted that considerable soluble constituent present in network of Figs. 2 and 3 was dissolved during ingot preheating and is not found in Figs. 4 and 5; ×100.)

CONTINUOUS CASTING

The term "continuous casting" is applied in this paper to any process where for a period of time molten metal is introduced into a mold and a solidifying ingot removed from the mold at the same rate. The direct-chill process is then a continuous casting process in which a short mold is used in connection with effective direct water cooling below the mold. The principles involved and the required location of the freezing zone are set forth in W. T. Ennor's U. S. Patent.[3] From this standpoint, it makes no difference whether ingots are cast singly or in multiples, or are supported by pinch rolls or by platens.

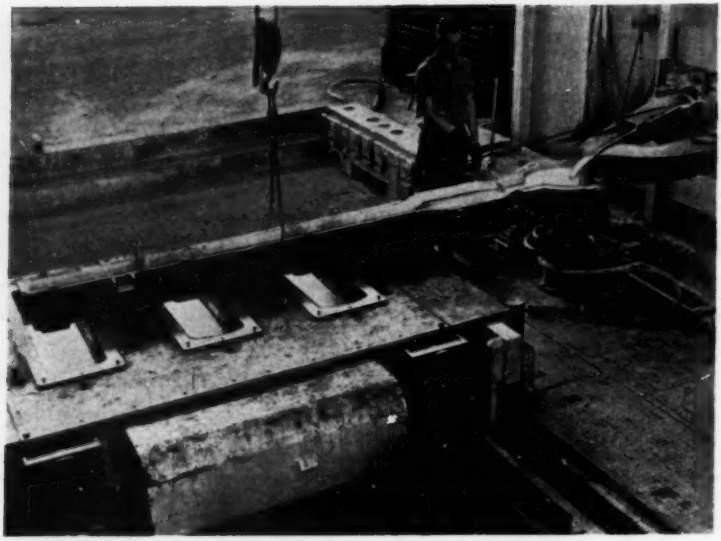

FIG. 7 DIRECT-CHILLED INGOT-CASTING UNIT AT DAVENPORT (IOWA) WORKS
(Molten metal flows from tapping spout of holding furnace shown in upper right corner, into distributing trough, and then into three molds.)

If attention is focused on the mechanical side of the operation, processes may be classified on the basis of the use of continuous or semicontinuous lowering of the ingots. To date, the direct-chill process has been operated commercially in a semicontinuous manner. Ingots up to about 12 ft in length have been cast by use of a supporting bottom platen that is normally lowered by a hydraulic mechanism.

On the other hand, a number of processes, mainly in the copper-alloy field, have been operated continuously by provision of pinch rolls to support the ingot during lowering, and of a flying saw below the supporting rolls. Mention may be made of Junghans-Rossi units in Germany and this country, of the American Smelting and Refining Company's process, and of a recent development in the casting of steel ingots made by the Babcock & Wilcox, and Republic Steel Companies.

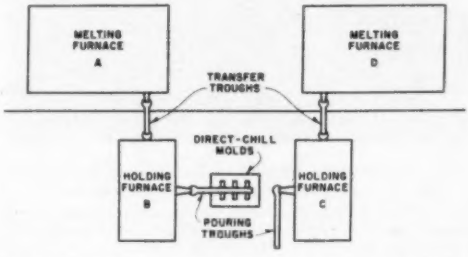

FIG. 6 DIAGRAM OF A TYPICAL LAYOUT OF TWO LARGE MELTING FURNACES (A, D), TWO HOLDING FURNACES (B, C), AND A SINGLE CASTING UNIT AT NEW DAVENPORT (IOWA) WORKS

There are, of course, advantages and disadvantages of both methods; it is not correct to think of the more highly mechanized continuous lowering units as being of necessity an advance in the art. Semicontinuous lowering lends itself to the casting of more than one ingot in a single drop. Even the largest ingots are normally cast three at a time, and small ingots may be cast with as many as fourteen supported on a single lowering platen. Semicontinuous units are cheaper, more flexible in operation, and avoid the obvious disadvantages inherent in sawing large ingots, particularly when they contain high internal stresses.

OPERATION OF DIRECT-CHILL PROCESS

The direct-chill process has been used for so many types and sizes of ingots that it is impossible to cover here in any detail typical casting equipment and practices. The author's company had more than 60 units in operation in the war year of 1944. Molten metal is led to the casting units directly from large stationary melting or holding furnaces, or is transferred from furnaces to casting units in electrically heated ladles of about 5000 lb capacity.

The mold is generally made of rolled aluminum sheet, although bronze and copper have been used successfully. It is usually $^1/_4$ in. thick and from 3 to 10 in. in height, depending on the type and shape of ingot being made. It is cooled by either a water spray or a water jacket. The ingot is generally cooled by a separate spray impinging on the ingot surface directly below the lower edge of the mold. A heavy oil is used for mold lubrication.

The height of metal maintained in the mold during casting is generally from about 2 to 7 in., depending on the alloy, size, and type of ingot being cast. The ingots are lowered at rates from about $1^1/_2$ to 7 in., or more per min, depending again on alloy, size, and type of ingot. Sheet-ingot sizes are from 8 in. $\times$ 30 in. to 12 in. $\times$ 48 in., extrusion ingots from 6 to 18 in. diam, and forging and rolling ingots from 6 to 24 in. square. Ingot lengths run up to about 12 ft. Sheet-ingot weights range from 1200 lb to 7800 lb, extrusion ingots from

300 lb to 2700 lb, and forging and rolling ingots from 700 lb to 6000 lb.

DETAILS OF COMMERCIAL D-C UNIT

Perhaps the best idea of a commercial D-C unit can be given by a description of the casting of large ingots for sheet and plate rolling in the company's new Davenport (Iowa) Works. Fig. 6 indicates a typical layout of two large melting furnaces, two holding furnaces, and a single casting unit. Melting furnaces are of about 25 tons and holding furnaces of 15 tons capacity. (Those who are familiar only with steel and copper must remember the relatively low density of aluminum, and think in terms of 75-ton and 45-ton furnaces). Metal flows through sloping troughs from the melting to the holding furnaces, and alternately from the holding furnaces to the D-C unit.

Fig. 7 shows the process in operation. Fig. 8 shows the ingots being removed from the platen by means of a crane after the mold-and-cooling-spray assembly has been moved out of the way on tracks that may be seen in Fig. 7.

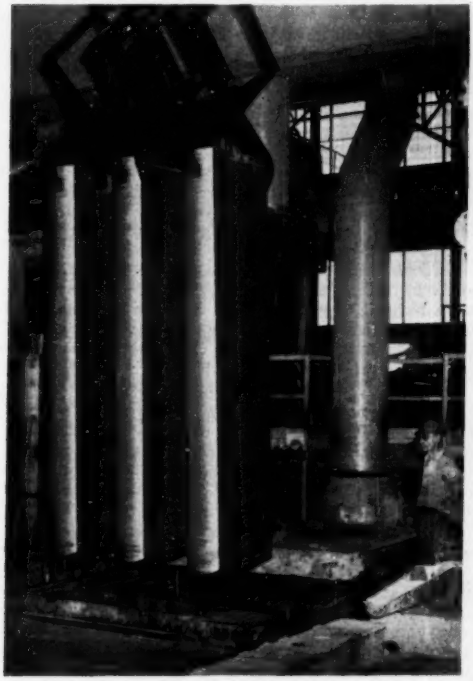

FIG. 8 LARGE DIRECT-CHILL SHEET INGOTS BEING REMOVED FROM CASTING UNIT AT DAVENPORT BY MEANS OF CRANE

(Mold and cooling-spray assembly has been moved to a position behind operator on tracks which may be seen in Fig. 7.)

Ingots are either 12 in. × 48 in. or 12 in. × 36 in. in cross section and about 136 in. in length. The lowering rate is normally from 3 to 5 in. per min. As the larger of these ingot sizes weighs about 7800 lb, this means that metal is frozen in the unit at a rate of around 25 tons per hr. Actually, the time required between casting cycles and for necessary furnacing operations reduces this to an over-all production rate of about 6 tons per hr. Five of the melting-casting units that have been described are in use at the Davenport plant.

Developing Technical Personnel at Hammermill

(*Continued from page 886*)

SUPERVISORY TRAINING

The fourth opportunity for development of our technical people is our periodic supervisory training meetings.

These are conducted by various management people and include discussions on developments in safety engineering, human relations, techniques of job instruction, labor contract changes, and special developments.

WORK-SIMPLIFICATION CONFERENCES

Another activity designed for personnel development which has been recently inaugurated is our work-simplification conference training. This is industrial engineering for the layman. Work-simplification conferences are presently being offered to supervisors and to most technical and other key personnel.

This program is designed to produce better company products and to render better customer service, at a lower cost and at the right time. This, of course, has always been the requirement of American customers.

Cost reduction through methods improvements has met increasing hurdles or obstacles in recent years. The obstacles certainly were not created by lack of technical or engineering knowledge. We believe that the point of view or attitude of "the man on the job" is the key to solution of many of today's toughest management problems.

Together with the know-how of our technically trained men and women, we are experimenting with work-simplification conferences as a means of bringing supervisors, technicians, and mill and office personnel into closer harmony.

Each of our first three conference groups in work simplification is comprised of 16 men and women from the 250 members of our management group. They represent various departments and mixed levels of the organization.

Each conference group meets for 36 hours during a 9-week period. The philosophy, tools, and techniques of work simplification are presented and discussed.

Typical case problems in industrial operations are studied for possibility of methods improvements. A number of visual aids are used, including sound and silent films. Company production problems also are brought in by members of each group for analysis and discussion.

Topics covered during the 9-week period include the following:

Work simplification and you
Work simplification and steady employment
Work simplification and measurement
The work-simplification pattern
"Still-picture" techniques
Analyzing methods for improvement
Work simplification and your effectiveness

After this basic work-simplification training is completed, the members of each group are provided with technical or other staff assistance they may require in working out new ideas. Movies of job operations may become necessary. Engineering problems may arise. Expediting may become important.

BEARINGS, LUBRICANTS, *and* LUBRICATION

A Digest of 1950 Literature[1]

JOURNAL BEARINGS AND BEARING MATERIALS

NEW experimental information on the operating characteristics of journal bearings appears in three categories: (*a*) Oil grooves and oil-pumping effects, (*b*) performance under rotating and varying loads, and (*c*) demonstration of the phenomenon of oil-film turbulence in high-speed bearings.

McKee and White (1)[2] evaluated the effects which several methods of admitting oil to unidirectionally loaded sleeve bearings have upon their friction, load-carrying capacity, and oil flow. The relative ratings are summarized in Table 1, from which the effectiveness of each design may be judged.

TABLE 1 RELATIVE RATINGS OF METHODS FOR ADMITTING OIL TO UNIDIRECTIONALLY LOADED SLEEVE BEARINGS

Design of oil feed	Friction rating	Load-carrying capacity rating	Rate of oil flow
1 Hole at top of bearing	Low	High	Medium
2 Holes at top and bottom	Medium	Medium	Low
4 Holes at 45 deg from load line	Medium	Low	Medium
Axial groove at top	Low	High	High
Circumferential groove	High	Medium	High
1 Hole in shaft	Low-Medium	High	Low
2 Holes in shaft	Medium	High	Low
1 Hole with flat in shaft	Medium	Very Low	Low

Withers and Wachal (2) studied the flow of oil from the main bearing of a running internal-combustion engine and found that oil flow while running is much greater than when stationary, and that it increases approximately as follows

$$Q = KN^{1.3}C^2P_i^{0.5}Z_i^{-0.4}$$

where the subscript *i* refers to inlet-oil conditions. Roach (3) evaluated a bearing as an oil pump and pointed out how oil from the high-pressure region of the oil film may be withdrawn for other purposes. Orton (4) describes the successful substitution of low-viscosity oil for the air in air-lubricated gyrocompass gimbal bearings.

D. A. Richards (5) has devised a stroboscopic method of determining the friction couple in balanced decelerating mechanisms by measuring the rate of deceleration. Knowing the moment of inertia, the friction couple causing deceleration may be calculated.

NACA Technical Memo. No. 1200 furnishes a translation of a paper by Buske and Rolli (6) describing an ingenious method for measuring oil-film pressures in a bearing without any interruptions or discontinuities in the bearing surface. Cohn and Oren (7) demonstrated that film pressures support the load in grease-lubricated bearings in much the same manner as in oil-lubricated bearings. K. B. Lawrence (8) has applied the finite-difference method devised by Christopherson to the problem of obtaining a solution to Reynolds' equation for a journal bearing of finite length, lubricated with a grease having non-Newtonian characteristics. The variation of apparent viscosity with rate of shear is taken into account by this method, and Southwell's relaxation method is applied to reduce the errors in the point-by-point calculation.

Simons (9) reported tests on cyclically loaded bearings which confirm the loss in load-carrying capacity predicted by theoretical considerations for load frequencies less than shaft speed. However, where the theory predicts an eccentricity of 1 (zero load-carrying capacity), when the load frequency is exactly one half the shaft speed, Simons found that the eccentricity ratio under these conditions was always less than 1. In other words, the bearing still possessed load-carrying ability under these critical conditions. Tests were run both with a rotating load and with a sinusoidally varying load with essentially similar results, but with the rotating load causing larger eccentricities at the critical frequency.

Reynolds' equation for fluid-film lubrication has been integrated by Cameron and Wood (10), assuming an incomplete oil film which begins at the point of maximum clearance. Full bearings of diameter/length ratios from 0 to 4 are treated. Calculated values of the function expressing side leakage in terms of journal dimensions are included.

Wilcock (11) described tests indicating that above a transition Reynolds number in the oil film given by $R_s = 41.1\sqrt{D/C}$, changes in performance indicating the effects of turbulence are found. These effects are a more rapid increase in power loss as speed is increased, a less rapid increase in oil flow, a lower than normal shaft eccentricity at a given Sommerfeld number, and a rapid increase in bearing temperature.

M. C. Shaw (12) discusses simplified methods of analysis which may be applied to bearings subjected to rotating and fluctuating loads in which both bearing surfaces may be in motion. It is shown that with both surfaces in motion, the load capacity is proportional to the sum of the two surface velocities. Solutions are obtained by reducing the complicated systems to the equivalent conventional journal bearing for which solutions are readily available. An interesting hydraulic analogy is offered to aid in understanding the behavior of dynamically loaded bearings in which the "squeeze" effect becomes a factor.

Gerard (13) describes development, theory, and some applications of a fluid bearing which derives the pressure for supporting load from exterior sources. The fluid may be anything from air to various petroleum oils. Load can be supported even though the machine is static. Coefficients of friction run as low as 10^{-6} for gas or air.

Little new material on bearing materials appeared during the year. However, Allen and Davis (14) found good sleeve-bearing performance from poor bearing materials. Tested under conditions of dirty lubricant, rough surfaces or misalignment, copper (99.6 per cent pure) outperformed either babbitt or cop-

[1] Report prepared by Dr. J. C. Geniesse with the assistance of the Special Research Committee on Lubrication. The summary for the year 1950 was based on the Engineering Index references on Bearings and Lubrication.

[2] Numbers in parentheses refer to the Bibliography at the end of the paper.

per-lead. Lewis (15) demonstrated again the value of good surface finish in increasing the high load range of hydrodynamic lubrication. Aluminum-zinc alloys were discussed by Heidebroek (16). Lead-bronze bearings for automotive use were described by Garre (17), and Raub (18) studied the effect of additions of up to 10 per cent lead to silver alloys. Wall (19) gives complete physical and mechanical properties of molded nylon with rates of wear in bearings and coefficient of friction in the Neely test machine. Fabrication aids and case histories are also included.

BALL AND ROLLER BEARINGS

Macks and Nemeth (20), in an NACA investigation with 75-mm-bore cylindrical roller bearings of three cage types with speeds up to 22,000 rpm and radial loads up to 1613 lb, indicated the one piece inner-race-riding cage type as being most reliable. This bearing operated with cage speeds greater than theoretical under certain conditions. Extensive data illustrate the effect of load and speed on bearing temperature and slip. Jones and Wilcock (21) report the mechanism of lubrication failure in high-speed ball bearings run at 13,200 rpm. Increasing oil-film thickness lengthened time to failure. Failure is a succession of (*a*) loss of lubricant, (*b*) localized heating, resulting in high ball loads and stresses, (*c*) spalling and pitting of contact surfaces, (*d*) ball skidding, separator failure, and jamming of balls. Lower speeds gave similar results although rate of failure was lower.

Factors one must consider when choosing ball and roller bearings are given in two papers. For oscillating service, Patterson (22) advises limiting load to 35 per cent of that of a single-direction bearing running at equivalent speed. Reducing ball size and packing it full of a fluid grease are also helpful. Machine-tool-bearing design suggestions are presented by Banninger (23).

THRUST BEARINGS

The theory of stepped plates and thrust-bearing sliders was discussed by F. R. Archibald (24). The slider of infinite width was treated after the manner of Lord Rayleigh, and the analysis extended to include side leakage. It was found that whereas the stepped slider of infinite width shows a load-carrying capacity some 29 per cent above that of the flat inclined plane, this advantage practically disappears when side leakage is taken into account.

AUTOMOTIVE LUBRICANTS

A symposium (25) on high-additive-content crankcase oils reports fleet and dynamometer tests show improvement in both gasoline and Diesel-engine cleanliness as the detergent content is increased. In some cases improvement is not very great, indicating that choice of crankcase oil should be based on economic analysis of experience. Fleming (26) and others ran dynamometer and fleet tests which showed (*a*) engine starting in cold weather depends in part on the viscosity of the oil at the starting temperature, (*b*) oil consumption depends in part on the viscosity of the oil at 300 F, and (*c*) oils containing viscosity-index improvers gave results which would be expected from their viscosities as determined in conventional viscosimeters.

In discussion Georgi (26), questions conclusion regarding "VI" improver and cites data showing that engine and operating variables may overshadow effect of oil. The wear characteristics of automotive-gear oils were studied by McKee (27) and others in a laboratory-modified SAE extreme-pressure-lubricants testing machine. Wear rates of oils meeting government specifications varied considerably with the highest values obtained with those containing the more chemically active additives. Further studies by Backoff (28) and others with hypoid oils in trucks and passenger cars show that several laboratory test procedures are necessary to predict the performance of an oil in all commonly used vehicles.

In a small volume, Bouman (29) discusses (*a*) properties of new and used engine lubricants, and (*b*) engine deposits and their relationship to operating conditions, fuels, and lubricating oils. These subjects are treated principally from the standpoint of nonadditive oils.

METALWORKING LUBRICATION

The role of lubrication in grinding has received serious attention during the past year, and a number of excellent papers have appeared on the subject. Sudholz, Manilych, and Mapes (30), using a sensitive chemical method (impregnated imbibition paper) for detecting loading of grinding wheels, distinguish between two types, metallic and gum. Both are influenced by the choice of coolant, and large differences are observed between different types of water-base fluids, even those which are not distinguishable by other experimental techniques.

Wagner (31) reports large differences between grinding fluids in regard to their ability to promote or retard an important type of wear of abrasives which he terms "attritious wear." He describes a means of measuring such wear which involves having a lightly loaded abrasive slider trace a helical path on a metal log.

A novel method of applying coolants to porous grinding wheels, with attendant advantages in lessened check-cracking, increased wheel life, and improved visibility, is described by Harrington and Childers (32). The coolant is fed under a guard or flange to the sides of the wheel near the axis, and centrifugal action carries it to the outer edge of the wheel where it is delivered to the work as a fine spray.

The latest theories of metal cutting and the action of cutting fluids, as advanced by Merchant, Shaw, Schmidt, and others, are reviewed at length in a recent book (33) by the American Society for Metals and are not further discussed here.

Mention should be made of a careful analysis of the probable state of lubrication in metal cutting by Bisshopp, Lype, and Raynor (34). They conclude that only a concept of a "discontinuous lubricant film" is compatible with the conditions of temperature and pressure which exist between a chip and tool.

On the more practical side, an extensive series of performance tests has been developed and applied to soluble cutting oils by the Production Engineering Research Association of Great Britain (PERA) (35). The tests were made at various dilutions and cover such aspects of the fluid as lubrication, corrosion inhibition, degree of dispersion, and wetting or spreading qualities.

The practical selection of cutting fluids with emphasis on tool life and economics, and the methods employed, are described by Tangerman (36) and by Suhadolnik (37).

A critical summary and recommendation for cutting fluids for machining stainless steels is given by Hambach (38).

BOUNDARY LUBRICATION

Dry Friction. The effect of oxide films in reducing friction by reducing the area of real metallic contact has been further investigated by Whitehead (39) with careful measurements of dynamic dry friction between metals in air at extremely small loads. Two values for the coefficient of friction were found, one low in the lowest load range, and another higher value at higher loads, owing to the breakdown of the natural oxide films. Friction measurements in a zone between these ranges were erratic. Dynamic dry-friction measurements made by

Tingle (40) at low speeds between a slider and freshly cut surface of the same metal showed that the friction, 4 sec after forming the fresh surface was substantially unchanged after longer times of exposure to air. It was shown also that oxide films are necessary for friction reduction by fatty-acid additives. Copper, iron, cadmium, magnesium, aluminum, and bismuth were studied.

An objection to theories of solid friction based on cohesion or adhesion forces between minute areas of contact has been that no normal adhesion forces can be measured for most combinations of metals. It has been shown by McFarlane and Tabor (41) that there is no detectable adhesion force for hard solids such as glass, platinum, and silver when dry. With soft metals such as indium, lead, and cadmium, cleaned by planing off a layer (40), appreciable adhesion was measured, the adhesion force being proportional to the load. Adhesion decreased steadily with time of exposure of the freshly cut surface to air; monolayers of oiliness additive reduced adhesion to a negligible amount. It is believed that failure to detect adhesion between hard surfaces is due to relief of elastic stress breaking the junctions gradually as the load is removed, and the difficulty of separating surfaces so that all junctions are broken at once.

Parker and Hatch (42) observed the area of contact between a hemispherical indium slider and a glass plate with a microscope while applying tangential forces much lower than those required to produce macroslip. It was shown that local microslip took place, causing a progressive increase in the apparent area of contact as the tangential stress was increased. The ratio of the apparent to the real area of contact remained constant. Measurable normal forces of adhesion were found on separating the surfaces; these are attributed to cohesion rather than welded junctions. Similar conclusions regarding changes in area of contact with tangential stress were reached by McFarlane and Tabor (41) in studies of the effect of load on friction down to very small loads, accompanied by adhesion measurements. Their results are explained on the basis of the formation and breaking of welded junctions.

Dry Lubricants. The demand for high-temperature lubrication in aircraft has led to comprehensive studies of various dry lubricants for steel on steel at calculated loads of 125,000–225,000 psi and 50–8000 fpm by Johnson, Bisson, and others (43, 44, 45). Graphite, molybdenum disulphide, tungsten disulphide, lead iodide, silver sulphate, iron oxides, and films formed by thermal decomposition of common lubricants on the surface were studied. It was found that molybdenum disulphide had the best all-round properties. Lubricant decomposition films all showed friction-reducing power, those from synthetics (notably silicones) appearing to be better at high speeds than those from petroleum. Studies were also made against steel using a rider made of hot-pressed mixtures of copper, silver, and molybdenum disulphide (44). Friction was low and virtually independent of sliding velocity, the disulphide films being maintained continuously.

A general review of dry lubricants is given by Stuart (46), who finds molybdenum disulphide disappointing, and zinc and magnesium stearates promising.

The use of nonmetallic bearings for circuit breakers is discussed by Bush (47). Laminated plastic bearings are shown to be far superior to metallic materials against steel; this superiority is discussed in terms of the physical properties of the plastic.

Additives for Boundary Lubrication. Experiments at high loads and sliding velocities by Bisson and others (48) show that, with many boundary lubricants, a rise in friction accompanied by a marked change in the character of the wear track takes place at a critical speed, above which the surface appears smeared as if melted. It is concluded that the effectiveness of these additives is proportional to their chemical reactivity toward the metal. Between 1 and 10 per cent, no significant effect of concentration was found.

Studies by Kluge (49) of friction and wear on steels, cast iron, and aluminum-silicon alloys, lubricated by saturated fatty acids, esters, and alcohols, show friction, in general, to be a linear function of the chain length of the lubricant and to be independent of the hardness of the bearing. Wear increases in all cases with increase in chain length. Similar increases in wear produced by friction-lowering additives are noted by Ramsauer and Wolf (50).

Thickness of Boundary Films. Hersey and Lowdenslager (51) have completed Karlson's mathematical analysis of the thickness of oil films between gear teeth, confirming the derivation of Karlson's equations and using his parabolic formula for the variation of viscosity with pressure. Numerical results check closely with those previously published using other pressure-viscosity relations. Relative film thicknesses are plotted in terms of the appropriate dimensionless variables, enabling the calculation of film thickness from gear dimensions, operating variables, and lubricant properties. The calculation is complicated by the necessity of correcting the pressure coefficient to fit the assumed pressure-viscosity relation. In the discussion a more general solution avoiding this difficulty is proposed, and the need for considering elastic deformation is recognized.

Thickness of the adsorbed films formed by oleic acid in a white oil was measured by Trillat and Brigonnet (52) percolating the solution through a tower containing steel balls until the oil-water interfacial tension showed no further change. The equilibrium film takes 4 hours to form and is approximately 500 Å thick.

Cameron (53), in an interesting series of experiments with a pivoted-pad bearing, contributed new data to the problem of the thickness of the oil film above which pure hydrodynamic friction operates. Steel surfaces lubricated with water, kerosene, and light mineral oil were studied at low loads and a speed of 290 fpm, measuring frictional drag and oil-film conductance. He found a linear relation between average surface roughness and calculated film thickness at seizure, the technique of surface preparation influencing seizure behavior. Two zones of boundary friction were found, one in which friction rises steeply to seizure. Initial contact occurred when calculated film thickness was three times maximum surface roughness, seizure when film thickness was twice the average surface roughness. This suggests that when the surface roughness is of the same order of magnitude as the film thickness, the actual film thickness is $^1/_3$ of the calculated value.

Marcelin (54) likewise distinguishes two zones of boundary lubrication for thickness below approximately 1 micron, one in which friction is higher than hydrodynamic, but in which no metallic wear takes place, and another at lower film thickness, where the friction is higher and metallic wear takes place. In another investigation, Marcelin (55) presents limited data to show that in a transition range between hydrodynamic and boundary lubrication, quite different laws of friction are obeyed from that in either the hydrodynamic (Newton's law) or boundary region (Amontons-Coulomb's law). In this region friction was found to be independent of load, and to decrease somewhat as the viscosity of the lubricant increased. The author attributes the formation of this film to the influence of the metal surface on the lubricant.

PROPERTIES OF LUBRICANTS

Foaming. Three NACA papers by Robinson and Woods deal with foaming of lubricating oil. In the first (56), the

authors conclude that foaming is a property of the mixture of hydrocarbons and not the result of impurities. Certain additives in the oil may increase the volume of foam and its stability whereas glycerol, diethylene glycol, or dibutyl phthalate will not foam under any conditions. Mixtures of aliphatic hydrocarbons or of alkyl benzenes do not foam, but mixtures of both of these types did foam. Further work (57) with undoped lubricating oil showed that air bubbles obey Stokes' law as they rise at room temperature whereas they rise more slowly in doped oil. Lubricating and antifoaming additives in aircraft lubricating oils may impede the escape of small bubbles from the oil by forming shells of liquid with a quasi-solid or gel structure around the bubbles. The third paper (58) deals with foaming in new and used aircraft oils and shows that used oils froth less, but the stability of the froth is greater. Altitude flying increases foaming.

Lubricating Greases. Carmichael and Robinson (59) report that pressure-gun applications may result in overgreasing or damage to bearing seals. Principal characteristics of greases for antifriction-bearing application are consistency, apparent viscosity, structural stability at elevated temperatures, resistance against separation of oil, chemical stability, water resistance, rust-preventive properties, and film strength. Vold and Vold (60) discuss the phase behavior of lubricating greases. Few normal soaps are appreciably soluble in hydrocarbons at room temperature but most of them become very soluble at temperatures above their melting points. One practical use to which phase diagrams of soap-oil systems can be put is to reduce the number of trial-and-error preparations.

Aircraft Hydraulic Fluids. Hydraulic transmission fluids are treated from a flammability viewpoint by Murphy and Zisman (61, 62) who cite two new laboratory methods, the incendiary and the fire-spray flammability tests, for studying these fluids. Few liquids were found to be resistant to all the laboratory tests for flammability. Adequate information is not at hand on health hazards and on the deterioration of rubber packings under practical conditions of long exposure and extreme temperature. Pollitt (63) states that the fire risk due to fractured hydraulic pipes in aircraft installations has been increased by the introduction of high-pressure systems. Several nonflammable fluids have inherent limitations in that they attack synthetic-rubber seals and gaskets. The author discusses a new fluid, the principal ingredient of which is a halogenated nonaromatic hydrocarbon. It is stable and has excellent physical characteristics; however, it causes excessive swelling of ordinary seals and packing, but is suitable with special packings. This fluid would not ignite when tested for flammability.

Synthetics. Extreme ranges in operating temperature have prompted the search for synthetic lubricating greases by Merker and Zisman (64). Silicone-base lithium-stearate greases offer advantages for antifriction bearings over a temperature range of minus 60 to plus 325 F. The silicone-diester-base lithium-stearate greases are suitable for minus 130 F to plus 250 F. The Air Force is seeking a single lubricant for satisfactory operation at extremely wide temperature ranges. Synthetic materials, such as dibasic acid ester, polyalkylene glycols, organic silicone compounds, halogenated hydrocarbons, and inorganic radical organic-base ester, were investigated by Rubin and Glass (65). Greases using sebacate and azelate diester oils are suitable at minus 67 F for ball, roller, and needle bearings operating normally below 250 F with short 300 F peaks. Polyglycol-derivative-base fluid was found equal to diester type and, combined with lithium soap, was superior to petroleum greases at low temperatures. Silicone greases have excellent temperature susceptibility but are unsatisfactory under high load and in all sliding-friction applications.

In aircraft engines a polyethylene-glycol derivative was not corrosive but it gave less protection to engine parts from corroding agents formed during engine operation than petroleum oil. They show greater leakage than do petroleum oils and in one case valve sticking was reported after 300 hours operation. Straight diesters were unsatisfactory, but blends with mineral oils stabilized to oxidation show good detergency and low pour points. Williams (66) reports that polyalkylene glycols have been used as lubricants for many different types of machines including internal-combustion engines. Their viscosity index and resistance to sludge and carbon formation is high. Solubility in petroleum lubricants is low at normal temperatures but increases with the temperature. Their antiwear qualities are good under low speed and high overload conditions, and they respond to conventional extreme-pressure additives. Fourteen grades of silicones are described (67) as colorless and inert, with high flash and fire points, relatively flat viscosity-temperature slopes, low volatility, negligible vapor pressure, low surface tension, high compressibility, good dielectric properties, and resistance to oxidation. They are good damping fluids and may be used as cutting fluids for machining plastics, but their load-carrying capacity is limited, and they are not suitable for lubricating steel sliding on steel. The value of silicones in boundary lubrication is shown by Newing (68) to be particularly significant where resistance to chemical action and high temperatures make it impossible to use hydrocarbons. Regert-Monod and Sequin (69) give an exhaustive paper on the composition, properties, and applications of silicones.

Load-Carrying Capacity. Compounds possessing a Cl_3C-group show good EP activity when blended in mineral oil. Bromine compounds have shown superior EP activity to analogous chlorine compounds according to Davey (70). Umstaetter (71) describes experiments made on a special test bearing arranged for measuring the temperature difference between the narrowest and widest sections of the oil wedge as a function of the load. The wedging action and load-bearing capacity of lubricating oils depends upon viscosity. Lubricating oils comprising solutions of high-polymer hydrocarbons in low-molecular hydrocarbons show a lower viscosity in the narrowest part of the lubricating wedge than they do in the widest part, so pressure and temperature peaks are flattened out.

Fluorocarbons. Simons (72) reports fluorocarbon compounds are remarkably stable. Their boiling points, freezing points, and viscosities are quite similar to those of hydrocarbons having the same carbon skeleton. Carbon tetrafluoride is thermally stable to 1100 C. As lubricants, fluorocarbons have low adhesion and cohesion, resist thermal decomposition and chemical reaction and, therefore, will withstand high temperatures. Solubility for fuel hydrocarbons is low, an advantage in internal-combustion-engine lubrication. They can be used in the presence of highly oxidizing gases, such as oxygen and chlorine. In air compressors, danger of explosions would be nil. However, such special lubricants, made entirely of fluorocarbons, are commercially unobtainable at present.

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POSTGRADUATE TRAINING *of* ENGINEERS *in* INDUSTRY

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THERE seems to be a general acceptance of the fact that teaching scientific engineering theory can be and is well done in the colleges. However, colleges are not set up to teach the practical aspects of design, application, production, and sales. In these fields, most manufacturers find it necessary and profitable to supplement college training with a training period of their own which ranges in length from a few months to two years.

Let me illustrate this with an example from my own experience. When I first arrived at the company's plant, I went out into the shops to visit a friend of mine who had come to Milwaukee at an earlier date. I asked him where he was working. He said, "In the transformer department." I asked him where that department was and he said, "We are in it." I then asked him where the transformers were and he said he had his foot on the start of one. What he had his foot on were the yoke plates of a shell-type transformer. There were some piles of silicon sheet steel lying around and also some copper coils covered with insulation surrounding a hollow fiber-composition cylinder.

The facts were that I had never seen a transformer outside of a tank—let alone one in the early stages of assembly. You could easily judge from this that I didn't know anything about transformers. This wouldn't be true as I had a degree in electrical engineering and knew quite a lot about eddy currents, hysteresis, I^2R losses, vector relationships, dielectric strengths, and other theoretical information associated with transformers. The college hadn't wasted its time telling me all about details of assembly of equipment and I see no reason why it should have.

In addition to practical aspects of engineering training, it has also been profitable in the cases of particularly gifted students, to develop means for their continued theoretical education.

In this article, I will use data and experiences from my own company. These will vary in many details from other training courses but a pattern has been sufficiently established to give a fair idea of the training problems encountered in industry and the methods used in solving them.

RECRUITING THE TRAINEE

Good training, we feel, starts right with recruiting. We visit approximately 60 to 70 schools per year. We interview 3000 or more students. The number we invite might vary from 200 up to 600 or more depending on the year and conditions. Our percentage of acceptances among the invitees may vary from 80 down to 30 per cent.

During recruiting interviews, we attempt to give the students a good picture of our company and its operation. Our methods of selection are based, generally, on three points—a man's grades, his personality, and his activities. Properly to weigh the value of his activities and his personality is not an easy matter. After continued interviewing, certain evaluating skills are developed. In large companies such as ours we are not particularly concerned with whether a man is a sales type, a production type, or a design and engineering man. Our problem is one of selecting top-notch individuals—we sort them out later. Of course, we are guided in general by different conditions. Right now, for instance, we are very alert to people who have an interest in production since that is our principal problem. If we were in the midst of a depression, we would be alert to people who have an interest in sales. These are trends, however, rather than rigorous policies.

Most of the students we recruit are in the mechanical and electrical field. However, our records show that in 1950 we also selected one or more students in the following categories: Chemical engineering, general engineering, industrial engineering, industrial management, metallurgical engineering, engineering physics, administrative engineering, basic engineering, industrial physics, and milling technology. We also have foreign students who are handled much the same as domestic students though they tend to concentrate more on certain types of equipment applicable to foreign countries. During the past year, one or more of these foreign students came from the following countries: Argentina, Brazil, Canada, Columbia, Egypt, England, France, North Africa, Norway, Poland, and Switzerland. Practically all foreign countries have had men in our Graduate Training Course in times past.

The men who accept our invitation are scheduled to arrive at the factory in groups of approximately 20 every two weeks throughout the summer and fall. Smaller groups start throughout the year.

Upon arriving at our factory, these men first take a physical examination. Occasionally we find a student whom we cannot accept. This is rare, however, since we advise them ahead of time to be fairly sure about their general health. After the physical examination, they go through the regular employment-office procedure and during this time are given the following psychology tests: Kuder preference, California test of mental maturity, Bernreuter personality test, and Bennett mechanical-aptitude tests BB and CC. They are also given an induction lecture which covers company history, safety, hours, and the type of information which everyone has to know whether they are a shop workman or manager of a department. The following day they are given talks by various members of the training staff concerning the actual operation of our Graduate Training Course, what we hope to accomplish, what we expect of the students, and the like. During this day the students meet a selected group of prominent men from the company who are representative of the different departments. These men are on the manager or assistant-manager level. We then take them on a tour of the plant. We also help them to find housing, and we explain to them the various policies with regard to hospitalization, insurance, and retirement policies of the company. We tell them about the social and sports opportunities of the community. Our Personnel Relations Department makes a special point of promoting sports activities, although the students are encouraged through their own organizations to initiate these activities. To do this, the student engineers have

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a club of their own. They are organized as the Allis-Chalmers Engineers Society (ACES Club), which sponsors a public-speaking club, dances, picnics, baseball, basketball, and other sports teams, and many other functions which add materially to a well-rounded life for the trainee.

GRADUATE TRAINING COURSE

Our Graduate Training Course is a two-year program although we have been forced to modify the length of it in times of a student shortage. We find that, in general, the students initially feel that two years is a long time for a training course and some are rather impatient with the length when they start. However, this attitude almost invariably changes to the point where they wish they had more time at the end.

On-the-job training is the principal method used. We attempt to place the students in different departments where they can actually do or observe the regular work of the department. During the first eight or nine months, we prefer to have the students work largely in the shops—mostly on tests and assembly jobs. We move them from one job to another on the average of every two months or less. In so far as possible, we do this at their request and to the locations they have selected. We particularly stress this voluntary aspect of our training. We feel that a mature student who has had 16 years of education and has been approved by our recruiters is a pretty level-headed fellow and with a little advice and a few suggestions from us he can go a long way toward selecting the kind of training that is best for him. In other words, he knows his own weaknesses and his own aptitudes better than we do. Particularly is this so if we give him the benefit of our suggestions and experience and our interpretation of the various psychological tests which he has taken.

After the eight or nine months in the shops, we bring him to the offices where, again, we move him from one department to another. The application departments usually require about four to six weeks each and the design departments two or three months. In addition to usual engineering jobs, we find some students interested in health and safety, wage analysis, employment, training, advertising, technical writing, purchasing, commercial research, and other odds and ends of the company's operation which might not at first seem to be suitable positions for engineers.

Through this voluntary method of selection, students choose training locations which appeal to them and, after having worked a while in such a location, they may decide they like the job and that it is what they would like to do permanently.

If a student and department agree on a permanent assignment before the regular training course is finished, we discourage staying at that work location. We would prefer that they work out, in conjunction with their future boss, work locations for the remainder of their training time which will give them a better background for their ultimate job. These matters cannot always be taken care of as we wish but this is the procedure we prefer.

We also send students to other plants where they have a special interest and where the products and work seem to fit into their goals and abilities. Some students go to four or five different plants during their training period. Training at the individual plants is similar to that given at the main plant in West Allis.

During the training in the offices, a number of lecture courses are given to the students. These lecture courses are used to give a fast over-all picture. As illustrative examples, we have a six-week lecture course on electrical equipment, and other courses on processing machinery, mechanical machinery, etc. One lecture course is on public utilities since they are an important part of our business. We also have a sales course which is run in a clinical fashion. Here the students, themselves, make the presentations, discuss sales application films, ideas, and the like. Some of the lecture courses run straight through with very little participation by the students. One meets half a day a week for an extended period of time.

GRADUATE STUDIES

Most of the actual learning about our equipment, however, is received through work in the various departments. The lecture courses are supplementary. Most of the department assignments are of a practical application nature.

To provide additional theoretical material, we have worked out with the Illinois Institute of Technology a program of night-school work which will allow a BS student to obtain a masters degree in eight years of one night a week work or four years of two nights a week work. We suggest, however, the one night a week course since there are a number of other activities to take up the other evenings. I.I.T. sends professors to our plant to teach these courses. We pay one third of the cost of tuition at the outset and another one third if the student completes the course satisfactorily. Some of the courses which we have given in this program of graduate study are as follows: Differential equations, symmetrical components, theory of synchronous machinery, advanced engineering mechanics, dielectrics and insulation of electrical equipment, magnetism and magnetic circuits, industrial management, power transmission, fundamentals of electron tubes, power system relaying, organization and executive control, advanced engineering mathematics, components of electronic circuits, problems in power system engineering, atomistic and applied nuclear physics, business policy, analysis and design of electric machinery, advanced thermodynamics, principles of organization, electricity and magnetism, advanced machine design, engineering mathematics, engineering economics, heat transfer and insulation, design of transformers, power system stability, applied mechanical vibrations, partial differential equations, research, lightning protection of electric power systems, production control, modern theory of alternating-current machinery, electron and nuclear physics, and modern power plants. The company supplies the meeting rooms and takes care of the administrative work. In addition to this educational opportunity, we, of course, encourage students to consider courses at the University of Wisconsin (Milwaukee Extension Division), Marquette University, or any other university in the vicinity of the plant at which they are being trained.

EXECUTIVE INTERVIEWS

After the students have been in our employ about a year we arrange a series of interviews with six or seven executives of the company. The student is interviewed during a period of 15 minutes to an hour, individually, by each of these six or seven different men. This is quite an experience for the student as well as the executive. Perhaps the word visit would be a better word to use than interview since it allows the students to get acquainted with men in responsible positions in the various divisions of the company. We feel that these visits give the student a sense of belonging and also allow him to pick up information which might be missed in his normal training routine. These men, most of whom are ex-trainees themselves, have a keen interest in this matter. Because of the wide variety of their background, they are also able to give the student some excellent suggestions. During the interview they have before them the psychological tests given the students. Periodically these men get together to discuss students. In addition to the information they have gained from the visits, they have a record of the student's success in his training locations. This

(*Continued on page 902*)

VINYL-RESIN COATINGS *in* PETROLEUM REFINERIES

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REFINERIES EXPOSED TO SEVERE CORROSIVE ACTION

VINYL-resin coatings for the most part are classed as specialty coatings, or coatings for specific and difficult conditions. In the refining of petroleum, because of the tremendous structures required, the large areas of exposed steel, and the extreme range of conditions found in refineries, the need for special coatings and for coatings which will withstand severe chemical, temperature, and weather abuse is very great. From the very beginning, the design of refineries has tended toward the modern open-work structure for equipment where the structural steel is exposed to the weather, and all of the complicated pipe systems and specialized processing equipment not only are subjected to the weather, but to all of the refinery fumes, steam, high humidities and, in coastal areas, to salt air as well.

Many of the fumes involved are extremely corrosive, such as sulphur dioxide, hydrogen sulphide, hydrogen fluoride, and ammonia. When materials such as these are combined with steam or high humidity, very high corrosive conditions are developed. The same is true for the exterior of the tankage which, of necessity, is located within a short distance from the refinery. Not only are corrosive conditions general on the exterior of refinery equipment, but also on the interior of storage tanks from crudes through finished products. All of the intermediate processing equipment such as run-down tanks, treaters, and blow-down tanks are included as well. Because of the open-work design, the continuous operation, and the fact that corrosive fumes are formed continuously, the refinery requires special coatings for high resistance to humidity, weather, and the whole range of chemicals from acids through alkalies. It is under these difficult conditions vinyl-resin coatings demonstrate to the greatest degree their extremely resistant properties.

WHAT IS VINYL?

In the past few years, the descriptive terms vinyl, vinyl coatings, and vinyl resins, have been applied to a large number of coatings and products without a real definition being given for these products. Theoretically, a vinyl resin is any material composed of a basic vinyl molecule, which contains a carbon-double-bond-carbon group. Any number of side groups may be applied to this basic molecule and, under proper conditions, polymerization will take place and a resin will be formed. It is not necessary to have a pure monomeric product in order to form a resin, but other vinyl monomers or other products containing the carbon-double-bond-carbon group may be included so that copolymers may be formed as well. Assuming these variations, it can be seen that there are hundreds of different combinations of molecules possible which would result in just as many different kinds of resins, all of which could be classified as vinyls. Some of the more common monomers used for polymerization alone or copolymerization with two or more monomers are as follows:

Acrylonitrile	Vinylbutyral	Vinylidene chloride
Butadiene	Vinyl chloride	Acrylate and methacrylates
Styrene	Vinyl acetate	Allyl compounds

Out of all of these possible combinations a few materials are outstanding in so far as coating formation is concerned.

The Vinylite resins,[1] are copolymers of vinyl chloride and vinyl acetate. A number of Vinylite resins are available which range in molecular weight from 5000 to 50,000 and which have a vinyl chloride-vinyl acetate ratio of from 85/15 to 95/5. The low and medium-molecular-weight resins in this group are excellent film formers with good solubility in their own specific solvents. The film when laid down is extremely tough, abrasion resistant, and has a very wide range of chemical stability from concentrated acids to concentrated caustic solutions. Extreme oxidizing acids, such as concentrated sulphuric, will tend to carbonize these films.

Another series of vinyl resins are those with the trade name "Geon."[2] These resins are composed either of vinyl chloride alone or are copolymerized from vinyl chloride and vinylidene chloride. This series of resins also vary from low-molecular-weight materials to extremely high insoluble-type resins suitable only for sheeting or molding. In resistance, Geon resins, in general, follow rather closely the vinyl chloride-vinyl acetate copolymers; they have good acid resistance, good alkali resistance, good resistance to salt solutions, and some of the resin formulations may be superior in resistance to moisture-vapor transfer.

The Saran[3] resins are also vinyl resins and these may be processed into coatings also. The Saran resins are somewhat different from the Geon and Vinylite in that they are composed of vinylidene chloride or copolymerized with acrylonitrile. The vinylidene chloride and acrylonitrile resins have a number of different properties from the two mentioned previously. They have a low moisture-vapor transfer rate and very low transfer of gases, such as carbon dioxide, oxygen, and so forth. They are not as resistant to ammonia and alkali and do not have quite the hydrocarbon resistance as the other materials. The solvent retention of Saran is high and when sprayed it tends to web. In general, however, their over-all chemical resistance is good.

There are also other important vinyl-resin products such as polyvinyl butyral, polyvinyl formal, and polystyrene, all of which are manufactured by the same or other chemical companies.

In general it can be said that the resins which are used for vinyl coatings provide tough semielastomeric films which have a high resistance to acids, alkalies, and chemical solutions. In addition, they have excellent resistance to oxidizing conditions and to aging. Their resistance to petroleum hydrocarbons is excellent and, for the most part, they are unaffected by gasoline, Diesel oil, lubricating oil, and crudes. The vinyl films are noninflammable and will not support combustion by

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[1] As manufactured by the Bakelite Corporation.
[2] Product of the B. F. Goodrich Company.
[3] Manufactured by the Dow Chemical Company.

themselves. Excellent fire-resistant coatings can be made from them. They have a low water absorption and a low moisture-vapor-transmission rate. The major limitation of vinyl coatings in a refinery is their resistance to continued high temperature. Except where specially formulated, vinyl-resin coatings are not satisfactory for temperatures above 180 F.

The number of vinyl resins available and their varying properties, make it possible to formulate vinyl coatings with almost any properties. They can be made to have a high moisture-vapor transfer or a low one. They can be alkali resistant or alkali reactive. One formulation of a vinyl coating can be used as an overprint lacquer on a plastic sheet to protect numbering and letters, while another vinyl coating may be designed for extreme chemical, weather, and water resistance. Such a coating might be for the exterior of tanks and adjacent piping in the vicinity of a cooling tower or somewhere on the lee side of an acid plant. Both such coatings are vinyl-resin coatings. However, it certainly would be foolish to use an overprint lacquer as a tank coating and vice versa. It should be stressed that the formulation of vinyl coatings is extremely important. This is especially true in refineries because of the varied and difficult conditions to which the coating is exposed.

FORMULATION OF VINYL COATINGS

The conditions under which the coating is to be used determine the formulation of the vinyl coating itself. For the exterior of equipment, tanks, structural steel, concrete surfaces, vinyl-resin coatings have been formulated as a single material which combines the properties of good adhesion with resistance to weather, fumes, splash and spray of acids, alkalies or salts. These coatings, for the most part, are made from lower-molecular-weight vinyl resins which are more soluble, slightly softer, and more easily worked. While they have the same basic chemical resistance of all vinyl resins, their resistance is of a lesser degree.

One of the vinyl resins mentioned was polyvinyl butyral. This is the resin from which has been formulated the metal-surface conditioner known as "wash prime." This particular formulation has proved to have some excellent properties where surface preparation is difficult and, except for severe chemical exposure or immersion, it provides a good base and surface treatment for the liquid-applied vinyl coatings.

Experience has shown that, for most immersion conditions, tank linings, and similar exposures, the only way a vinyl coating can be effective and make full use of the properties of the basic materials is to formulate them into a system coating. By a system coating is meant the use of a prime, intermediate, and seal coat. There are good reasons for formulating in this manner. Prime coats are for one purpose only and that is to tie the following coats tightly to the underlying surface. The prime coat of necessity must be highly resistant, or the coating would be built on a quick-sand foundation. In addition, however, it must be penetrating, must have good wetting properties, must apply easily, and when dry it should provide a good base over which the other coats can and will strongly adhere. The intermediate coats need have none of the prime properties as long as it is possible for them to be compatible and adhere to the prime coat. The main purpose of these coats is to build thickness, density, and, by their thickness, to level out the small hills and valleys in the surface over which they are applied. These coats must be highly resistant and have a low porosity. The final coats of the system are ones which provide a seal over the entire surface and shall by their low pigmentation provide a very dense almost pure vinyl-resin film over the whole surface. This type of formulation has proved extremely effective in very severe chemical exposures which range from concentrated caustic soda to acidic copper-sulphate solutions.

While the system coatings described have been subjected to immersion under difficult conditions, it is possible to go even further with vinyl resins and to use the highest-molecular-weight types which are the toughest and most resistant to all chemical solutions. These resins, for the most part, are soluble only with difficulty, and, therefore, cannot be used as a liquid coating. However, they can be formulated into sheets which may be applied to concrete or steel surfaces by adhesives or mechanically locked into concrete surfaces. Also, while having high molecular weight, these materials still have the valuable property of being thermoplastic and, when properly formulated, may be heat-welded to themselves. Under these conditions tanks or structures can be lined with a continuous plastic lining in which pinholes, holidays, and other failures of painting techniques are eliminated. These linings also have appreciable thickness in that they range from .030 in. to $\frac{1}{4}$ in. in thickness. With such linings, permanent coatings are obtained with even extremely difficult chemical solutions. Such linings have proved excellent for hydrochloric, sulphuric, and phosphoric-acid tanks and for concentrated acid salts such as copper chloride, copper sulphate, ferric chloride, and the like.

SURFACE PREPARATION AND APPLICATION OF VINYL COATINGS

Vinyl-resin coatings of any type have one basic requirement, namely, that they be applied properly over a perfectly clean dry metal or concrete surface. Most coating failures are caused by improper applications and by poor surface preparation. The life of any coating can be improved and multiplied several times if care is taken in application, and if the surface over which the material is applied is clean and dry. The reason these conditions are exaggerated with vinyl coatings is that, ordinarily, they are used where other materials fail. Inasmuch as the conditions under which vinyl coatings must stand up are continuous exposure to acid or alkali fumes, actual immersion in acid solutions or continuous contact with a corrosive gas, it can be understood readily that the surface preparation and application of these materials must be of the highest type. This point is well demonstrated when account is taken of the fact that a vinyl coating is relatively thin, for the most part being only a few thousandths of an inch in thickness, and that this film separates two highly reactive materials. These are, oxygen, acids or alkalies on the exterior of the film and iron or concrete underneath the film. Under these conditions, if the film is not continuous, then an immediate reaction can take place between these two reactive products.

Because vinyl-resin coatings are used only where difficult corrosion problems exist, application cannot be overstressed, and yet it must be pointed out that there is nothing actually difficult in the application of vinyl coatings. Ordinarily they are applied by standard paint equipment. They may be brushed or sprayed without difficulty, and care is really the only major requirement which varies from that of conventional painting.

Surface Preparation in Detail. The following application points are stressed: (1) Surface preparation; (2) adhesion; (3) coating thickness; and (4) continuity of coating.

Surface preparation is naturally first, and a thoroughly clean dry metal surface is required for the application of vinyl coatings under refinery conditions. The best type of surface preparation for vinyl coatings is a sandblasted surface. By sandblasting, the steel surface is cleaned thoroughly down to a gray metal. The surface is not only cleaned but it is broken up so that the actual surface area of the steel is multiplied several times, which provides mechanical bond and tooth for the coating. Sandblasting is advantageous inasmuch as it can be used on existing structures, and the equipment used for blasting is portable.

The next method of surface preparation is that of acid-pick-

ling. This is second best. By acid-pickling, all mill scale, rust, and corrosion products are removed from the surface of the steel, and a thoroughly clean steel surface can be obtained. Acid-pickling provides some tooth for the coatings; however, it does not provide the same degree of tooth as sandblasting. Acid-pickling is ordinarily restricted to new work, inasmuch as pickling of existing structures is impossible.

Another method is by the use of power sanders. This equipment is portable. It removes the majority of all rust, mill scale, and corrosion products. However, it does not remove them entirely. It is definitely a third best method.

Chipping and wire brushing constitute still another method. It is felt that this is the least desirable method of surface preparation in that only the heavy corrosion scale and corrosive products are removed. It is better than no surface preparation at all but at the same time it does allow for continued underfilm corrosion because of corrosion products left on the surface.

Underfilm corrosion is particularly important in refinery operation as hydrogen sulphide and sulphide corrosion are very common owing to the increased use of sour crudes. Should steel surfaces which have been exposed to sulphide corrosion be coated, and the surfaces are not thoroughly clean, the following reaction will take place: Hydrogen sulphide or other sulphides, will react with the iron to form iron sulphide. This, in turn, is reacted upon by moisture from the moisture-vapor transfer through the coating to form iron hydroxide and regenerate hydrogen sulphide. The result is a continuing underfilm corrosion with the resultant blistering and film disruption. This particular reaction has been demonstrated many times where sulphide corrosion is a particular hazard. It is particularly graphic when an old tank has been cleaned and has been repaired with a new plate. When the interior is sandblasted it will be found that the old plate in the tank will turn dark very quickly even though blasted to gray metal initially, while new plates will remain an even light gray for a much longer time. In this case it is the sulphide which remains in the surface pores of the metal which oxidizes on exposure to the air. When coated it has been found that the old plates will fail much more rapidly than the new because of underfilm corrosion. It can be understood readily, therefore, that if a coating is applied over steel surfaces containing iron sulphide the life of any coating, including a vinyl, would be limited.

While on the subject of sulphide corrosion and surface preparation, the procedure suggested for overcoming any remaining sulphide on the surface is to blast or power-sand the surface thoroughly, then oxidize the surface by either flame treatment or washing with water and allowing to rust. The heat-treatment is preferred. Following the oxidation, reclean the surface by sandblasting, preferably, or power wire brush. Remove all of the oxidized sulphides on the surface. Steel surfaces treated in this manner should be equal to new steel when coated.

Film Adhesion. Second to proper surface preparation in the life of a coating is its adhesion. Without proper adhesion, coatings will tend to fail by early blistering or underfilm corrosion due to moisture vapor passing through the coating into the areas of poor adhesion. Adhesion of vinyl coatings is dependent upon proper surface preparation. This is due to the vinyl resins themselves having a nonpolar structure and a high molecular weight so that wetting of the surface is difficult. Surface preparation, therefore, is not only important to provide a thoroughly clean surface, but one which will aid the adhesion of vinyls by providing a mechanical bond as well as a chemical one. Dust or moisture on the surface of the steel during the application of vinyl coatings will retard adhesion materially and, in order to protect against minute quantities of either of these, it is recommended under all conditions that the vinyl-coating primer be brushed into the metal surface in order to help the coating wet the steel thoroughly by mechanical means.

Coating Thickness. Coating thickness is important in any coating; however, as with adhesion, it is of major importance in vinyl coatings. The reason for this is the relatively low solid content of vinyl solutions because of their high molecular weight and tendency to become gel-like in structure where high concentrations of resin are put into solution. While many paint coatings have a total nonvolatile of 50 to 75 per cent or even more, as in the case of linseed-oil paints, vinyl coatings have a total nonvolatile in the neighborhood of 25 to 30 per cent. It can be seen, therefore, that it is important to maintain an even coating of uniform thickness wherever severe chemical corrosion is found. The resistance of a coating to moisture-vapor transfer is directly proportional to the coating thickness, and this is one of the reasons why pinholes and thin spots in the coating tend to fail first. Rough areas in the steel, rivets, bolts, edges, and corners are all areas where the thickness of a coating may be neglected. These rough and uneven areas when not coated with the same thickness of the coating as the smooth areas, become focal points for corrosion. All such points should be given special care, in order to make certain that the coating thickness is uniform over all areas.

Continuity of Coating. Just previously it has been mentioned that coating thickness is an important point. Continuity of the coating means that this thickness should be maintained evenly throughout the entire coating application and that pinholes, holidays, and thin spots in the coating must be kept to a minimum if proper results are to be obtained under severe corrosion. In all of the foregoing, we have assumed that the corrosion was severe and that the best possible coating and coating procedure are required to protect the underlying metal.

The degree of the corrosion determines almost entirely the amount of surface preparation and care needed during coating application. It also determines the need for the coating itself. In other words, if ordinary atmospheric exposure is the problem, then neither vinyl coatings nor the care in surface preparation and application is required. If, however, the interior of the tank is to be coated to protect against sulphide corrosion, then all of the points mentioned should be watched very carefully, and a vinyl coating is indicated in order to withstand the severe conditions. Also, it might be said at this point that a vinyl coating, because of its resistance, when properly applied with the proper thickness and proper formulation, will outlast conventional paint several times even under moderately severe corrosive conditions.

EFFECTIVE PROTECTION FOR REFINERY EQUIPMENT

There are innumerable examples of refinery equipment which have been more effectively protected by vinyl coatings than with any other method of coating protection. Some examples of these are as follows:

Exterior of caustic tanks.
Sulphur-dioxide blow-down tanks.
Acid-plant areas subjected to sulphur-dioxide fumes.
Salt-water vertical-tube ammonia coolers.
Exterior of gasoline treaters subjected to continual condensation.
Interior of lead-lined gasoline treaters.
Interior of Perco treaters.
Gas area on interior of floating-roof tanks subjected to sour crude and raw gasoline.
Interior of pan tanks subjected to sour crude and raw gasoline.
Tank exposures subjected to general refinery fumes, high humidity, salt air.
Marine installations such as steel wharfs and above salt-water pipe lines.
Interior of acid-sludge tanks.
Interior of pipe lines subjected to treating liquids.
Interior of concrete pipe for refinery sewers.

It is felt that this is an impressive list of areas which are sub-

ject to severe corrosion in refineries. It is believed also that these uses demonstrate the versatility and wide resistance of vinyl-resin coatings. An example is the exterior coating for caustic tanks. The coating is subjected to caustic spillage and overflow from the top of the tank. When this happens 50 per cent caustic soda may remain on the exterior of the coating for an hour to several days, before it is washed down. Because of the very high alkali resistance of the vinyl-resin coatings, it is possible for these coatings to withstand not only the atmospheric weathering to which these tanks are subjected but also this severe chemical treatment. A number of caustic tanks have been lined in various refineries. Previous coatings have had a life of only one overflow or one serious spill. Vinyl coatings have been unaffected for more than 2 years of service under these conditions.

Another example and one which is even more severe is the interior of sulphur-dioxide blowdown tanks, Here the conditions are gaseous sulphur dioxide, 20 to 50 per cent caustic soda; so that the coating in this case not only is subjected to continuous exposure to caustic soda but must at the same time withstand sulphur-dioxide fumes above the caustic-soda liquid level Vinyl coatings were tested under these conditions for more than a year on panels. They were unaffected during that time. The tank was then completely cleaned out, sandblasted, and a vinyl-coating system applied to the interior. This has been giving satisfactory service under these severe conditions for more than 2 years.

Another severe condition is that of the interior of acid-sludge tanks. These are the tanks into which the sulphuric-acid sludge is pumped after the treatment of petroleum products. The sulphuric acid is relatively concentrated so that the body of the tank immersed in the liquid sludge is not as great a problem as the area above the liquid level. It was stated prior to the application of vinyl coatings to the underside of the roof and above liquid level in these tanks that, if the coating would last 6 months, it was longer than any other coating had ever withstood these conditions. The interior of the tank was sandblasted, a vinyl-coating system was applied, the tank was placed in service, and inspected after 2 years continuous use. The coating was found in perfect condition with no breaks over any coated area.

These exposure examples have all been severe chemical exposures, and they were picked to demonstrate the limits to which vinyl coatings may be used. It is believed that they not only demonstrate the resistance but tend to indicate that the lesser corrosion problems in refineries can be handled readily and easily by these materials.

CONCLUSION

In review, the vinyl resins have the basic resistance and chemical properties required for refinery corrosion. They are formulated for maximum utility from single-solution coatings for fume conditions, to system coating for severe chemical immersion, or they may be applied as molded linings where the maximum resistance is required. They are applicable not only to new installations but are readily applied in the field by standard paint equipment, requiring only care in order to obtain an impervious film. The vinyl coatings have been proved by actual application to operating equipment in some of the most severe refinery exposures. With these properties and background, vinyl-resin coatings already have proved themselves to be an essential in refinery maintenance and protection.

Postgraduate Training of Engineers in Industry

(*Continued from page 898*)

record covers the following items: Quantity of work, quality of work, initiative and resourcefulness, ability to get along with others, understanding of work, and attitude. These discussions give us a basis for placement. In practice, however, the real placement is done by the student himself, who finds a spot he likes and in to which he sells himself. The Committee is able to approve these arrangements and guide them somewhat without seeming to take away the students' prerogative of selection. This guidance work has been a most successful feature of our training program.

FELLOWSHIPS

After placement on a permanent assignment, we continue to follow the activities of these men. We attempt to have them keep up their graduate studies and we are constantly on the alert for high-grade capable people whom we can advance further through fellowships. We have selected students for fellowships on such items as the Network Calculator, Magnetostriction Vibrations in Transformer Cores, Axisymmetric Flow Through Radial Turbomachines, and the Relationship Between Pellet Strength and Grain Size of Magnetite and Hematite Ores at High Temperatures. While the company offers various types of fellowships, in general, we select a man who shows a strong aptitude in a certain class of equipment. We send him to a college which specializes in that field. Usually, we pay all his tuition fees and a salary while he is at the school. This is equivalent to that received by a Graduate Training Course student. We also purchase such special engineering instruments or equipment as he might need for his study at the school.

An example of a fellowship with which we are quite pleased and which we would like to duplicate is the case of a man who came to us in the summer of 1942. He had a BS degree. Subsequently he took various graduate courses associated with one of our products and eventually received a masters degree. His progress in the company as well as in his graduate courses was of such an outstanding nature that in 1949 he was given a special fellowship working toward a doctorate. He submitted a thesis on "Analytic Methods for Computing the Design of Centrifugal Impellers" last fall and received his doctorate this year. This is a particularly attractive type of fellowship to both the man as well as the company and all the work along the line was of direct industrial benefit to the company as well as personal benefit to the recipient of the degree.

In summary, I would like to emphasize that our program for making the best possible use of newly graduated engineering students is to select the best men available; to make every effort to keep them happy by giving them a sense of participation in our company and by encouraging appropriate social activity; to give them the best possible practical knowledge through wide experience in on-the-job-work, supplemented by lectures; to encourage their continued theoretical growth through enrollment in graduate courses; and to be ever on the alert for particularly gifted individuals who have the potentialities for advancement to even higher accomplishments through fellowships.

Training Young GRADUATE ENGINEERS *in* INDUSTRY

By W. F. McMULLEN[1]

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IF we are going to discuss the training of young graduate engineers in industry today, we should examine first our raw material—the young man as he steps across the threshold of his university.

Much has been said before about university training of engineers. There have been shifts of emphasis on various parts of the curriculum. In some Canadian universities the trend is now away from specialization and back to the basic fundamentals.

Dr. Robert E. Doherty, the late great president of Carnegie Institute of Technology, defined the qualities to be cultivated in the university as follows: "The habit of scientific thought; the ability to organize such thoughts for clear logical expression; a genuine grasp of fundamental science; a historical perspective of social, economic, and institutional developments; cultural balance, and the ability to co-operate in group activity."

FUNCTION OF THE UNIVERSITY

From this, then, let us assume that the university has guided the student to a sound scientific foundation, and helped him develop the ability to learn from experience. To quote Dr. Doherty again: "An undergraduate course in engineering should train students to 'become' engineers, and not train engineers."

The university then has produced a raw material of great potential, but nevertheless a raw material in the industrial sense. It will require proper development to bring it to full fruition. It is as if we had been given a seedling; we can leave it alone and let nature take its course. It may survive, and it may become the great tree it was destined to be. Or we can nurture and care for it, and assist and protect it. The possibilities are infinitely greater that it will achieve its destiny under the latter conditions. Hence the need for the industry training program to guide the young engineer toward his destiny; to take him from university graduation to his rightful place in his profession. It is a great challenge, and we in industry today must face it.

We have been operating a training program for young graduate engineers for over 50 years. As would be expected, we have learned many things in that time. Sometimes we feel we have learned more about what not to do than what to do. There have been many changes in our outlook and our practices during that time, and we will be trying continually and changing until we achieve an ideal system. While we have not yet arrived at this goal we have come a long way. In the following our approach to some of the problems encountered and our present solutions to some of them will be considered.

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ELEMENTS OF A TRAINING PROGRAM IN CANADA

Speaking of Canadian industry as a whole, we have some training problems that it is felt may be peculiar to Canada. Our industrial economy is relatively recent, and our major industries are concentrated in central eastern Canada. Because of the wide dispersal of our universities and our people, many of our graduate engineers have had no industrial undergraduate experience. Many have no conception of industrial activity, and some have never even seen a major industrial plant. Thus we feel the transitional period from university graduation into industry requires particular attention.

We consider that there are four essential ingredients in any industrial training program:

1 To make an initial selection of the most promising graduates for our company.

2 To provide the necessary training and development for these graduates, based on their own background and capabilities, to prepare them for greater responsibility in whatever phase of our operations they may ultimately find themselves.

3 To place them upon completion of their initial training period to the best advantage of both the individual and the company.

4 To follow their progress and development both during and after their training period throughout their entire career with the company so that we will:

(*a*) Continue to develop each man as an individual.

(*b*) Know what experience and ability we have available in our organization.

(*c*) Make the best use of this ability and experience.

Before discussing some of our experiences in each of these phases, two additional points should be mentioned that are essential to the success of any training program, whatever the industry. These are as follows:

1 The complete and enthusiastic support of top management. Since so much in any training program depends upon example, an enthusiastic top management can engender the right spirit throughout all levels whose responsibilities will include the training of engineers.

2 Any training program must be a long-term proposition A company which is concerned only with immediate gains and which organizes its training on this basis is going to be disappointed. It will be inclined to blame training in general, not its own conception of training.

SELECTION OF GRADUATES FOR TRAINING

University Visits. Since we have been visiting the Canadian universities for over 20 years, our visits are expected by the several faculties, and we are welcomed as an interesting addition to the curriculum. Our tour is organized carefully, providing adequate notice and a supply of literature, interview forms, and any other available company material. We like to talk to the class as a whole before doing any interviewing as this not only saves considerable of the students' and inter-

viewer's time but also by means of a general discussion brings out many interesting questions. We regard this as a great privilege. We fit our timetable into that of the university and do not expect them to disrupt classes because we happen to be on the campus. In some instances we deal directly with the dean or department head concerned, and in others with the director of placement. Each university may have its own ground rules, and we try to follow them carefully.

Planning our trip well ahead and giving adequate notice allows the students a chance to read our literature, fill out the necessary forms, and sign appointment sheets. We use an interview form as distinct from an application form during university interviews. Some students have the impression that to sign an application form commits them to accept any offer we might make. Therefore our form, which has been changed twice in the last few years, asks enough questions for a proper interview, and in addition provides information about some of the company activities. It carefully avoids any questions about race, color, or creed.

Our latest form, which is again due for revision, is a four-page effort with an attempt made to provide a rating scale not readily readable upside down. We have decided this form is too bulky so we are going back to a double-sided page. We tried an interview check list with a list of characteristics for the interviewer to check off, but have discarded this as everybody seems to show the same pattern.

In our most recent effort we have decided merely to leave a space for the interviewer to write in his comments, and whether we are or are not interested in the student. Other than points of clarification in the data supplied, we believe it preferable for the interviewer to avoid writing down anything in front of the student. This not only makes the interview more difficult but it will be found that the student "grapevine" will have the rating system pretty well "taped" before the day is over.

Interviewing. Interviewing university students is a great experience. We should not overlook how important this interview is to them, and how their whole future career depends upon those few minutes. Do not accept this responsibility lightly and do not let it deteriorate into a routine. One will meet a wide range of people, from the shy, nervous, and almost tongue-tied boy, who has steeled himself to the ordeal and who requires very careful handling, to the lad who takes the whole procedure very much in his stride.

Evaluating the Students. We feel that in a 10 or 15-min interview we can get only an indication, with whatever degree of accuracy possible, on relatively few characteristics. The student's initial impression and appearance, voice and manner of speaking; something of his personality; his attitudes toward such things as his work, his profession, his prospective employer, and his career. We may even get an indication of how his mind works by the way he organizes his thoughts. From the university staff we can get some further indications of his scholastic ability, his leadership among his fellows, and perhaps one or two other points. With present swollen classes, many university staffs are unable to give much assistance other than scholastic record. The author suggests that our universities could help both the graduate and industry by making a periodic appraisal over his 4 or 5 years, and giving industry the benefit of such appraisals.

We have not had any experience in the use of "personnel evaluation" for selection at the universities. Time is an important consideration here, but we are now proposing to use such methods during the training period before placement.

Proposals to Students. We always try to make definite offers before we leave the university. It is a good idea to see the men of particular interest a second time. It enables the man to clarify his thoughts and ask questions. One of the author's company friends likes the students to bring along their wives to this second interview, realizing the influence they may have on the man's final decision and future career. Finally, we write every man we interview a personal letter whether we hire him or not.

Next, our program will be outlined, its development traced, why some changes have been made, and where we think we stand today.

METHODS OF TRAINING

Teacher-Pupil Method. This is a method whereby an instructor tells the student what to do. This is also referred to as the "hole-in-the-head" method whereby facts are poured in and apparently stored.

Learning-by-Doing Method. This is the best way to learn or fully appreciate a job.

Personal Apprenticeship Method. This is essential for personal development. It is in essence the selection of the right supervisors for our young graduates' training assignments so that their example and interest become an integral part of the whole program.

We regard these last two methods as by far the most desirable, and we keep the lecture system to a minimum.

The company's Test Engineering Program whereby young graduates in electrical and mechanical engineering, engineering and business, and engineering physics, enter the company, is essentially learning by doing. In its original conception it was primarily concerned with the testing of the company's finished products. At that time the universities produced few electrical engineers, and it was obvious that industry would have to look out for itself. While we were primarily manufacturing apparatus and thought of engineers mainly in terms of the design and development field, this provided an excellent background. However, as our products became more diversified and complex, and engineers tended to go into almost every phase of business activity, it was evident that we had to expand our program. While we have since included assignments in engineering, manufacturing, sales, and construction, the name "test" has remained, and after 50 years, we still call it the Test Course.

Thus the essential purpose of our program is to provide a transitional period between the university and absorption into a permanent assignment, to allow the student to become acquainted firsthand with industrial equipment and the adaptation of his theoretical knowledge to the practical.

We endeavor to keep our program as broad as possible. Our experience has been that, while a few graduates may have fairly definite ideas about the type of career they desire, the majority are not at all sure. Thus we like to give them four or six varied assignments each of about 3 months' duration. In this way they become intimately acquainted with a number of the company's operations and, by means of conferences, plant visits, and personal interviews, will come to know many of the others. Thus, after these assignments, they will be in a better position to select, with the help of company officials, the type of work in which they are most interested, and for which they may be best suited.

In an effort to develop a sense of responsibility in our young graduates, we attempt to make the assignments of some importance and an integral part of the production process. In our test departments we use students almost entirely for all testing other than routine commercial tests. This affords some immediate return on our investment but, far more important, it enables the student to learn to fit into manufacturing schedules and develop the sense of responsibility and confidence so necessary in an engineer.

We also attempt to develop leadership and the ability to

co-operate with others, by having the students work as a team, with each man progressing from junior to senior responsibility in his group until he moves on to a new assignment to begin all over again.

PRODUCTION TEST ASSIGNMENTS

For instance, in a production test assignment, the students might have turned over to them on the completion of assembly, a large motor generator set for a steel mill. They would be required to prepare the machine for testing, and then run the tests required by the Engineering Division. They might be called upon to carry out special tests for a customer's inspector. On completion of the tests they analyze the data to see whether the machine does or does not meet engineering or customer specifications. We expect them to analyze our products critically and carefully. We feel this assists in the development of a sense of responsibility, clear thinking, technical knowledge, and teamwork.

Similarly in an engineering assignment they will be given current development problems of some importance, not just time fillers, under the guidance of an older engineer. They are given the problem and are expected to develop their own ways and means of carrying it out.

Manufacturing assignments might involve a study in plant layout, a new process, manufacturing-loss control, or a production bottleneck.

Whatever the assignment, it must make the man feel he is doing something important—that he is making a worth-while contribution. All assignments should be under constant critical review to make sure they are contributing to the whole program.

Toward the end of his series of initial assignments the student is guided by means of interviews and conferences into a more specialized field in which he is interested and for which he has shown the greatest aptitude. This is the third important ingredient of our training program—correct placement.

PLACEMENT PROCEDURE

We do not regard placements at this stage as necessarily final, and many young graduates may still be uncertain about their future inclinations. At present we use the results of interviews and performance records as a basis for guidance. We have used "personnel evaluations" in a few cases with encouraging results. In several instances they have enabled us to make a proper placement of men we would otherwise have lost. It is our intention to continue to use them on a larger scale as one of the tools in making proper placement.

After this initial placement which might be in an engineering or commercial department, or a manufacturing division, or elsewhere, we continue to use the rotational assignments for training. The length of an assignment might be 6 months to a year now instead of the 3 months in the Test Program. This system of rotation not only teaches a man at this stage how to adjust to new problems and new people but, even more important, teaches him different jobs and the relations between them.

We use and encourage other methods of supplementary training; for example, constructive courses on effective presentation, public speaking, methods of supervision, and so on, are given periodically in various divisions. We try to avoid courses that can be classed as "interesting—but so what?" University extension classes in various subjects and recommended reading as suggested by the Engineers' Council for Professional Development are encouraged.

RECORD OF INDIVIDUAL PERFORMANCE

Three of the essential ingredients of an adequate training and development program have been mentioned, namely, initial selection, the initial training, and the initial placement. The author is almost inclined to think the last is the most important, although we did not always appreciate this fact. We feel that we are just beginning the job now, but its need is so obvious it is surprising that we did not realize it sooner. That final essential is this: A continuous appraisal and record of each individual's performance and development throughout his career.

Sounds simple, doesn't it? Yet how many frustrated people do we see who are always wondering just what the boss thinks of them. How many people make the same mistakes day in and day out because no one has bothered to correct them. There are the cases where someone thinks he is going to have to discharge a man. Maybe he has been making the same mistake for years and yet no one took the time to try to straighten him out. The final failure is ours, not his.

Rating systems are always good for rousing arguments. We are working on our third or fourth in the last few years. We have gone from complicated to simple, to complicated again. Right now the simple ones are in again. What we feel we want a rating system to show is: How is he doing on his present job; what can he do to improve, or what additional training or assistance can we give him to make him improve; what is his ultimate potential, and what does he need to move further toward its realization? Then there is the school of thought that says a blank sheet of paper and a pencil are the best rating tools.

Thus our training program must develop the man. Just as we evaluate each assignment to see that it is contributing to the whole, so much more must we evaluate the man after each assignment to measure his progress to date. It is not enough merely to "rate" a man and enter it in the record book. We think it should be discussed with him.

DISCUSSIONS ON INDIVIDUAL PROGRESS

There are still some of the school who say "why doesn't he know he's doing all right, I haven't told him differently, have I?" It works the other way too often. Very conscientious good men will worry about how they are progressing. We have lost men for this reason, and we have failed to develop men to their maximum potential for the same reason. A few points to be gained from such a discussion are as follows:

It will "let him know how he is doing," and point out both his strengths and his weaknesses. It will eliminate or reduce anxiety and uncertainty.

It will "show where he needs to improve" and how he can go about it.

It will "build that personal relationship" which means so much to all of us.

It will "give him a chance to tell us" what is on his mind and of any way he thinks we could help him to be more effective.

It will "get him to do a better" job.

The result: A better man.
A happier man.
Better performance on the job.

It is a priceless opportunity and we feel it is particularly necessary in the case of new graduates. After all, they are used to being brought up to date on how they stand frequently by means of quizzes and examinations. They are also used to a passing grade of, say, 50 per cent. In industry they learn with a shock that the passing grade is considerably higher, but that too frequently no one tells them anything about themselves unless they do something very right or very wrong.

Having made our rating and discussed it with the man after

(Continued on page 909)

APPLICATION *of* STATISTICAL TECHNIQUES *in* TIME STUDY

By GEORGE D. WILKINSON[1]

GEORGE D. WILKINSON & CO., OCEANPORT, N. J. MEMBER ASME

IDEALS OF "SCIENTIFIC MANAGEMENT"

THE essence of the philosophy of Frederick W. Taylor, founder of the modern management movement was the substitution of fact for opinion, the development of management as a science rather than as an art. He and his associates insisted upon the whole phrase, "scientific management." But the movement, like any dynamic process, has changed. The adjective was gradually dropped, and today those who employ the entire phrase are thought to be either outmoded or else pursuing a hopeless ideal. The emergence of this newer attitude has been concurrent with the influx into the movement of specialists from fields other than engineering. Having backgrounds and training not quite as thoroughly imbued with the ideals and methods of science, the newcomers have been inclined to consider science as a fetter for the creative imagination, rather than as a tool for more effective work and thinking.

This paper assumes that engineers still retain their affection for the original phrase and still cling to the ideal that in the long run facts are better bases for action than the most highly cultivated intuitive judgments. Within a group of engineers the appeal to strengthen the scientific foundations of any part of the movement started by Taylor should not fall on deaf ears.

Of all the professional groups within the management movement, time-study engineers have remained the most devoted to the concept of "scientific management." The entire justification for this technique, as a matter of fact, consists in the claim that it replaces subjective opinion with scientifically determined facts about rates of working. The devotion to science, however, is more a matter of lip service than of fact. Science constantly strives to clothe its conclusion in more and more rigorous mathematical formulations and to eliminate all possible sources of subjective bias. Techniques for accomplishing these ends have been considerably refined since the days of Taylor and Barth, but time-study men have failed to keep step. They have, in fact, taken pains to reduce the mathematical element of time study to a minimum, and to refine subjective techniques as a substitute for objective determinations.

The failure of time study to develop its mathematical tools has been brought about largely by the fact that the profession has not encouraged a distinction between its professional men, engineers, and the rank and file of time-study men. The latter are usually shopmen selected because of their experience and knowledge of the operations to be studied and their ability to perform the simple mathematics currently required for time-study analysis. Although these men in general are far superior to college-trained engineers as stop-watch recorders, they are not, and generally cannot become, professional men. They can only become more and more proficient in techniques which can be explained thoroughly in a few days, and adequately learned in a few weeks or months. This paper is addressed to those who have the responsibility for training the line workers, to the trained engineers who have the responsibility for developing the techniques which their subordinates will faithfully follow.

In keeping with his unwillingness to recognize the distinction just made, the time-study engineer had tended to utilize his professional societies as adjuncts to his training program. Thus he has encouraged the presentation of papers simplifying the processes of time study, so that his subordinates could attend without becoming lost in technical details. Program chairmen, recognizing the possibility for swelling attendance by presenting programs attractive to the larger group of non-professional workers, have readily acceded to the demand for "practical" papers. The result has been the gradual atrophy of the spirit of scientific research in the profession.

Similarly, writers of textbooks on time study have tended to minimize the mathematical aspects of the analysis of data. Some even go so far as to hint that mathematical analysis is a dangerous substitute for experienced judgment in selecting the time value to be used as a standard. This attitude, although not a break in the original tradition, is indeed a far cry from the painstaking scientific objectivity which was the goal of Taylor and his associates.

CURRENT TECHNIQUES IN TIME STUDIES

Two different means of obtaining an experienced judgment have been developed and are currently in vogue in American time-study practice, i.e., leveling and rating. Each of these practices has been criticized adequately by adherents of the opposite school of thought, and nothing can be gained by adding to the controversy here. Both techniques, however, even when carefully and skillfully applied, are highly subjective. Impressive evidence has been offered to show that a group of men can be trained to use them to achieve consistent results, but continued training of the group as a whole is necessary if the results once achieved are to be maintained. Few time-study departments, moreover, take the trouble to train new analysts to become consistent with the veterans, and fewer still conduct a continuing program to insure that all analysts maintain their consistency.

This factor of subjective judgment in time-study analysis opens present-day time standards to the criticism that they lack scientific validity. Regardless of how well time-study engineers may convince their colleagues that they are able to train analysts to become objectively subjective in rating or leveling, outsiders to the profession are not likely to be impressed. No other science claims to be satisfied with anything more subjective than the irreducible minimum of observational errors.

Losing patience with such critics is of small profit. An increasingly bitter battle is developing between the professional

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time-study engineer with his dream of scientifically determined time standards and those who would discredit time study or abolish it altogether. Time standards and wage incentives are constantly subject to attack. If critics can establish in the minds of management and the public that time study is a crude subjectively empirical technique, not at all scientifically rigorous, the status of both profession and practitioners is in serious jeopardy. In this situation fratricidal strife is worse then useless. The subjective elements in time-study analysis must be minimized, or the claim of scientific validity for time standards must be dropped. The latter course is the easier, and is the one apparently chosen, even by the few time-study engineers who, in recent years, have attempted a critical evaluation of the profession.

RETURN TO THEORY

The former alternative is more difficult, but not, surely, impossible. It cannot be done by one person, or in a short time. Only the entire group of people professionally interested in time study can do it. A shift must be made from the preoccupation with techniques and the practical aspects of taking time studies to a consideration of the hypotheses and theories which have been the common assumptions of time-study men since the days of Taylor. Because engineers generally are reluctant to associate themselves with theorists, many may object to the course here proposed because of its frank call for a reappraisal of theory. Theory, however, even so-called "pure theory," cannot be ignored by the engineer. The effect of the developments in nuclear physics upon both mechanical and electrical engineering is a lesson which all engineers can learn with profit.

Space does not permit attempting here to do the entire job called for. No attempt can be made to develop a set of hypotheses to serve as bases for creating a new set of theories consistent with modern notion of scientific validity and with current conceptions in fields which border on time study, such as psychology and physiology. The limitations imposed upon this paper permit only a plea for a more rigorous treatment of the data of time study, so that they may better serve to test whatever hypotheses may later be proposed.

TIME STUDY AS A RESEARCH FUNCTION

Time study is a research function of production, and the problem of the time-study analyst is similar to the problems of research workers in many other fields. He has a mass of numbers representing measurements of a more or less closely defined phenomenon. His task is to translate all of these numbers into a single figure to represent not only the data he has accumulated but also any other set of similar data which he or anyone else might gather. The time-study man has permitted himself to be baffled by the abstract nature of this problem, whereas his fellow scientific research workers have turned to statistics. Biologists, psychologists, economists, and others have adapted the theoretical techniques of statistics to their specialized needs, and have, in the process, contributed to the advancement of the discipline from which they borrowed. Should not time-study engineers, whose training is so thoroughly grounded in mathematics, be able to walk in the same path?

Methods of treating time-study data advocated in current textbooks vary according to the personal preferences of the author. The usual methods for determining a value to serve as a standard, the mean, median, and mode, have their supporters. In addition, some unique techniques have been developed. Typical of these is the "selected minimum," in which the analyst chooses the lowest time recorded for each motion-time element, unless this minimum time seems to him to be too low—or possibly not low enough—in which case he selects some other "minimum" from his set of readings. In practically every case, regardless of the method proposed, the analyst is advised to circle values which are "too high" or "too low" and to omit them from his calculations. Thus, in addition to whatever subjective factors may have been introduced when the data were leveled or rated, or by the errors in reading the stop watch, another element is introduced when an attempt is made to translate the data into a time standard. It is not inconceivable that the next step in the development of this approach will be the announcement that no stop watch is needed at all, because the trained and experienced man can decide by merely watching an operator and applying his highly developed sense of "normal time" not only the relative rate of speed at which he is working, but how long he ought to take to do it!

Developments in the field of inspection in recent years point the way for time-study engineers. The use of statistical techniques have offered so many economic and technical advantages for controlling quality that engineers are adopting them despite the fact that inspectors, like time-study men, are not, as a class, sufficiently educated to be able to comprehend them. Consequently, "statistical quality control" is making remarkable contributions to the techniques of statistics. Intricate formulas and the involved discussions of the validity of the techniques employed, which, if the truth were known, many of the scientific research workers did not themselves understand, have been replaced with a few simple formulas, some easily understood tables, and a set of charts to portray graphically the results so that they can be grasped easily by the nontechnical mind.

Although many of the achievements of statistical quality control are applicable to time-study analysis, a slavish copy of its techniques will not suffice. Time study requires its own specialized adaptations if it is to utilize statistics effectively. The present state of mathematical statistics, as well as the applications which have been worked out to meet the needs of various scientific research projects, must be investigated. New techniques peculiarly adapted to the requirements of time study and enabling time-study men to treat their data as objectively and as scientifically as other research workers treat theirs must be worked out.

APPLYING THE STATISTICAL METHOD

One step in this direction is offered here. The gathering of data to establish a time standard is influenced by two considerations readily agreed upon even without mathematical justification. The first of these is that, if a sample selection of a small number of measurements, as, for example, time-study readings, is taken from a large number of such measurements, the average of the sample will not necessarily be the same as the average of the whole group from which it was taken. The second is the fact that the larger the number of measurements in the sample, the more likely is the average to be close to the average of the entire group of data. From these two considerations is derived the common-sense conclusion that the greater the number of time-study readings included in the determination of a standard, the closer will it be to the true standard.

The natural question, then, is, "How many readings must be taken to insure an accurate standard?" Time-study men have a variety of answers: "Ten or twenty." "Enough to establish a trend or cluster." "Enough to give a good average."

Statistics provides an objective, verifiable, although not categorical, answer to the question. When the nature of the data is to vary, no exact determination can be made of a single number representative of the entire set of data. The answer can

be stated, however, in terms of the probability of being within a desired percentage of the true average. The probability and percentage of accuracy desired can be set as close to certainty and 100 per cent as desired, but a practical limit is established by the fact that the greater the certainty and accuracy desired, the more data must be gathered. It is not to be supposed that the hestitancy of the statistician to claim unqualified accuracy for his results is a sign that they are unreliable. On the contrary, his qualifications are guarantees of reliability which completely are lacking in answers given by those who ignore the laws of probability.

STATISTICAL QUALITY CONTROL

The chief objection, presumably, to the use of statistical techniques to obtain averages of time-study data is that they are too complicated to be used economically by time-study departments pressed to develop standards. The comparatively recent developments in statistical quality control, however, have pointed the way to the overcoming of this objection. Most of the complicated and difficult computations can be standardized and set up in tables. Then the procedure for making an objective determination of the validity of the average can be made simple enough to be followed by anyone with a good grounding in arithmetic, and the only judgment involved is a simple determination as to whether a given number is greater or less than another one.

Table 1 has been prepared to aid in the determination of probabilities that the arithmetic mean, or average, of a sample is within 5 per cent, plus or minus, of the mean that would be obtained from an indefinitely large number of readings. Although time does not permit an explanation of the method of constructing the table, only a few words are necessary to describe its use. The values shown in the table for a given sample size and per cent of probability represent the minimum value of a ratio to be described presently. In use, the analyst determines the ratio, and then refers to the table to see if it exceeds the value given in the appropriate line and column. If so, he can state the probability of the mean of his sample set of figures being within 5 per cent of the mean he would have obtained from a very large sample. If not, his recourse is to secure a large sample and repeat the process, or else to analyze his data to see whether a better definition of his elements or more careful timing could reduce the variation sufficiently to give the desired probability with the same number of readings.

The ratio in question is simply determined by the formula

$$m = \frac{(\Sigma X)^2}{(\Sigma X^2)}$$

where

X = any number in sample to be averaged
ΣX = sum of all numbers in sample
ΣX^2 = sum of squares of all numbers in sample

APPLICATION OF METHOD

To illustrate the procedure, two means determined from the same sample will be investigated. The first mean was obtained from ten readings. The second is based upon fifteen readings, the first ten of which constituted the sample for the first case. We might suppose, to introduce color into the example, that two time-study men had made simultaneous studies of the same operator, but that one, perhaps more conscientious than the other, had taken fifteen cycles whereas his fellow had taken but ten. In Table 2 are shown the calculations performed by the analyst with ten readings. The readings are listed in the column headed X. Then from memory or from a table, the squares of the readings are entered in the column headed X^2. The sums of the X's and X^2's are determined and entered at the foot of the respective columns. Substitution of these values in the foregoing formula, as shown in the calculations beneath the table, gives a value of 9.0909 for m. Entering Table 1 on the line for samples of 10, we find that this value is less than that shown under the 50 per cent column. We have no assurance, then, that the average of 10.4 obtained for this sample of ten readings has even a fifty-fifty chance of being within 5 per cent of the true mean for this element. The analyst must conclude, therefore, that a larger sample is required.

Table 3 shows the computations for the sample of fifteen

TABLE 1 VALUE OF m

No. of readings in sample	Probability that observed mean will differ from the true mean by more than 5 per cent — Per cent							
	1	2	5	10	20	30	40	50
4	3.9991	3.9986	3.9970	3.9946	3.9889	3.9809	3.9689	3.9494
5	4.9976	4.9964	4.9935	4.9890	4.9788	4.9649	4.9442	4.9106
6	5.9954	5.9934	5.9887	5.9816	5.9658	5.9444	5.9127	5.8614
7	6.9924	6.9894	6.9825	6.9723	6.9497	6.9193	6.8744	6.8021
8	7.9886	7.9845	7.9751	7.9612	7.9307	7.8897	7.8293	7.7323
9	8.9840	8.9786	8.9663	8.9483	8.9087	8.8557	8.7779	8.6528
10	9.9787	9.9718	9.9562	9.9335	9.8837	9.8174	9.7195	9.5645
11	10.9727	10.9641	10.9449	10.9169	10.8558	10.7745	10.6552	10.4660
12	11.9659	11.9555	11.9323	11.8986	11.8250	11.7275	11.5849	11.2977
13	12.9584	12.9460	12.9184	12.8783	12.7913	12.6758	12.5076	12.2398
14	13.9500	13.9355	13.9032	13.8564	13.7547	13.6198	13.4236	13.1150
15	14.9410	14.9241	14.8868	14.8326	14.7153	14.5599	14.3341	13.9784
16	15.9312	15.9119	15.8690	15.8071	15.6732	15.4962	15.2381	14.8350
17	16.9207	16.8987	16.8500	16.7798	16.6279	16.4271	16.1373	15.6824
18	17.9094	17.8847	17.8298	17.7508	17.5795	17.3546	17.0283	16.5209
19	18.8973	18.8696	18.8083	18.7198	18.5286	18.2776	17.9150	17.3504
20	19.8846	19.8537	19.7855	19.6872	19.4755	19.1976	18.7956	18.1760
21	20.8711	20.8370	20.7614	20.6530	20.4185	20.1118	19.6702	18.9885
22	21.8568	21.8193	21.7362	21.6168	21.3593	21.0233	20.5387	19.7920
23	22.8419	22.8006	22.7096	22.5788	22.2972	21.9286	21.4012	20.5932
24	23.8261	23.7812	23.6819	23.5393	23.2322	22.8316	22.2613	21.3754
25	24.8097	24.7604	24.6528	24.4979	24.1653	23.7304	23.1118	22.1655
26	25.7925	25.7395	25.6226	25.4547	25.0944	24.6251	23.9565	22.9357
27	26.7747	26.7174	26.5911	26.4102	26.0219	25.5182	24.7999	23.7061
28	27.7560	27.6943	27.5582	27.3631	26.9466	26.4047	25.6331	24.4693
29	28.7365	28.6703	28.5240	28.3150	27.8685	27.2871	26.4657	25.2163
30	29.7164	29.6454	29.4888	29.2650	28.7857	28.1653	27.2874	25.9648
31	30.6956	30.6196	30.4523	30.2131	29.7019	29.0429	28.1093	26.7064

readings on the same element. The value for m is 14.3124. Entering Table 1 on the line for a sample of 15, we find that this number lies between the 40 per cent and 50 per cent columns. There is slightly better than a fifty-fifty chance of being correct within 5 per cent, and, depending upon the importance of the job he is studying, the hypothetical analyst may or may not decide to use the mean of 11.2. As a matter of interest it might be added that a larger sample of 180 readings yielded an average of 11.6.

Table 1 has been worked out to indicate a deviation of 5 per cent above or below the true mean. Similar tables, of course, may be drawn up for greater or smaller deviations. The analyst need know nothing whatever about the theory behind the tables. If he is able to add and to do long division, he can use the tables to obtain objective assurance as to the theoretical validity of his results.

The technique has two advantages for the analyst. On the one hand he is prevented from putting his faith in results which are not accurate enough. On the other hand, he is relieved from the compulsion to continue to take readings indefinitely in order to be absolutely sure he has enough data.

TABLE 2 TESTING VALIDITY OF SAMPLE OF TEN READINGS

Reading no.	X	X^2
1	8	64
2	14	196
3	12	144
4	11	121
5	9	81
6	10	100
7	7	49
8	10	100
9	8	64
10	15	225
10	104	1144

Calculations:

$$\text{Mean} = \frac{\Sigma X}{N} = \frac{104}{10} = 10.4$$

$$m = \frac{(\Sigma X)^2}{\Sigma X^2} = \frac{(104)^2}{1144} = 9.0909$$

m_{50} (from Table 1) = 9.5645

TABLE 3 TESTING VALIDITY OF SAMPLE OF FIFTEEN READINGS

Reading no.	X	X^2
1	8	64
2	14	196
3	12	144
4	11	121
5	9	81
6	10	100
7	7	49
8	10	100
9	8	64
10	15	225
11	15	225
12	13	169
13	13	169
14	12	144
15	11	121
15	168	1972

Calculations:

$$\text{Mean} = \frac{\Sigma X}{N} = \frac{168}{15} = 11.2$$

$$m = \frac{(\Sigma X)^2}{\Sigma X^2} = \frac{(168)^2}{1972} = 14.3124$$

m_{50} (from Table 1) = 13.9784
m_{40} (from Table 1) = 14.3341

ACCURACY OF METHOD

Although the procedure can be employed with data that have been rated or leveled, its power lies in its application to unmodified stop-watch readings. If it is used to test the validity not only of averages obtained from the study of a single operator, but also of the average of the averages of several operators, it gives assurance that the resulting standard is representative of the time which could have been obtained from studying all similarly qualified operators. The resulting standards are more valuable than those determined by the usual methods. The fact that all variations must be accounted for means that the standards must be more precisely defined and the conditions of their applicability more accurately described than is likely to be the case when wide variations are either dropped or adjusted to "normal" by rating or leveling. Further the fact that only the stop-watch readings contain a subjective element means that the results of all analysts who use this method are comparable.

CONCLUSION

Published time data arrived at in the way described will be universally applicable, subject only to whatever allowances may be necessary in different organizations to care for accepted fatigue factors and kinds of incentive plans in use. The data of time-study men, if this method is adopted, can become as valid as any other scientific data, and can be added to the findings of other scientific workers to throw light upon the difficult problems of fatigue, training, and other human factors in industry. Finally, standards determined in this way cannot be attacked for lacking scientific objectivity.

Training Young Graduate Engineers in Industry

(Continued from page 905)

each assignment in such a way as to develop him, we should continue this practice throughout his entire career.

This evaluation can be made annually after his training assignments are finished, but it should be regular, and in the author's opinion, preferably at a time other than his salary review. The matters under discussion can then be discussed more objectively without any feeling that there is an ulterior motive.

This means records and follow-up. Engineers should have no difficulty in devising suitable forms for record purposes. We actually are establishing two basic types. One is a personal history sheet designed to record background information and experience. It is kept up to date as a man changes positions or duties. We attempt to record additional comments on patents, awards, papers presented, and so on. The rating records are kept separately in a confidential file, but the two in combination provide an excellent source of information when seeking men for specific jobs and responsibilities.

CONCLUSION

This has been our experience in operating a training program. We believe we have a tremendous amount yet to learn. But it is interesting, worth while, and a lot of fun.

In the final analysis the purpose of a good training program is twofold:

1 To find, train, and develop the man.
2 To make the best possible use of his capabilities.

A PROGRAM *for the* ENGINEERING PROFESSION

By CAREY H. BROWN

CHAIRMAN, ENGINEERING MANPOWER COMMISSION, ENGINEERS JOINT COUNCIL. MEMBER ASME

PREVIOUS speakers[1] have discussed the role of engineering in modern society, availability of engineering manpower present and future, and the resources for development of such manpower and the government agencies and policies affecting technical manpower supply and utilization. In the present unsettled international situation the latter is particularly important in view of the necessity that we adequately support and man the sources of technological preparedness for war.

Beyond the necessity for technological preparedness in the military sense the engineering profession is faced with the challenge of increasing the productivity of industry and improving the material standard of living. Either in itself constitutes a ringing challenge, but when the two are superimposed the necessity for aggressive attack upon the problem becomes even greater. In this period of our history it is not merely essential that technology develop and produce the weapons and equipment essential to the maintenance of military superiority, but that, at the same time, it carry out its major share in the development and production of articles of such attractiveness, usefulness, and serviceability to the civilian economy that the cost of military preparedness can be borne. The wreck of our civil economy would be as disastrous as military defeat. Maintenance of strength in our civil structure as well as in our military establishment is essential. In both the role of the engineer is a dominant one; supply of engineering manpower is a critical problem; the failure to make full utilization of available engineering skills is a wasteful procedure which must be eliminated.

THE SUPPLY OF ENGINEERS

Dean Hollister's paper[1] has fully disclosed the inadequacy of engineering manpower to meet the needs both present and in the near future. The multiplicity of advertisements for "technical personnel wanted" attests to the present need; the figures of engineering enrollment in the colleges attest to the need of the near future. The data as to the numbers entering engineering curricula at the beginning of the present college year indicate that the trend toward lower engineering enrollment has not been reversed—or at least not significantly reversed. This emphasizes the necessity for effort at the local level to convince more young men—and perhaps young women as well—of the wisdom of entering engineering colleges.

There are perhaps two main factors entering the process of decision in the mind of the high-school graduate on this subject. The first factor is the essentiality and importance of engineering as a profession, and the second is the fitness of the student, both as to natural aptitude and inclination and as to educational preparation, to undertake the rigors of a course of engineering study. Conditions of employment, salary, recognition, and the like, likewise enter the decision. These are items whose significance the law of supply and demand is already demonstrating to employers, as evidenced by the nature and content of the engineers-wanted advertisements in the technical journals and the metropolitan dailies. The importance of the engineering profession must be sold, not merely to the high-school boy mapping a career, but also to the employer of engineers, and to practicing engineers themselves.

The statement that high-school preparation is deteriorating, in so far as preparation for entry into engineering colleges is concerned, has been made from time to time. It is no doubt true in certain quarters, less accurate in others, and not at all true in still others. Two reasons have been advanced for such change in the high-school output. These are, respectively, the loss of male teachers of science and mathematics during the war and the increasing attention to instruction in the so-called "humanities," either as a result of such losses or because such increased attention was of itself considered desirable. To the extent that engineering or pre-engineering students are now being adversely affected by policies permitting the draft of their instructors or their call as reservists, these policies should come under careful scrutiny.

Attack by the Engineering Manpower Commission upon this phase of the problem sprang from the first startling announcement of the facts by Dean Hollister[2] in December, 1950. This attack has been made along three main lines. First of all, effort was made to secure correction of the charts and data exhibited over the past few years in college registration quarters and elsewhere indicating that engineers were in oversupply. These data were unfortunately supported by the statements of certain prominent industrialists. However, the caution has been carried too far, as was made manifest by the figures cited in a preceding paper. Those figures, and its own studies, proved convincing to the Department of Labor, with the result that its charts and data, which apparently are quite effective in influencing the student at the time of entering college, have been changed to more truly depict the present situation. The Engineering Manpower Commission has also sent out to principals, and guidance and science teachers in 23,000 high schools throughout the country, data on the same subject in an effort to secure increased engineering enrollments. These two measures, we trust, have been of some effect, but unfortunately they were probably too late to influence many selections among those entering college this fall. The effect, after another year, should be more pronounced, particularly if the shot-gun method necessarily employed in these first

[1] Other addresses at the Convocation were:
"Reflected Light Is Not Enough," by A. C. Monteith, vice-president, Westinghouse Electric Corporation, Pittsburgh, Pa.
"Resources—Present and Future," by S. C. Hollister, dean, College of Engineering, Cornell University, Ithaca, N. Y.
"Government Agencies and Policies," by M. H. Trytten, Office of Scientific Personnel, National Research Council, Washington, D. C.
Concluding address at a Convocation on "Engineering—Its Future" held under the auspices of the Engineering Manpower Commission of Engineers Joint Council with the co-operation of the Engineers Society of Western Pennsylvania, Pittsburgh, Pa., Sept. 28, 1951. See page 944 for a report of the Convocation.

[2] "The Developing Critical Shortage of Engineers," by S. C. Hollister, MECHANICAL ENGINEERING, February, 1951, pp. 121–122.

efforts to broadcast the facts as to shortage of engineers are supplemented by the efforts of engineering organizations and individual engineers throughout the country to disseminate this information in their own communities.

The third step taken was the Engineering Manpower Commission's survey of engineering needs made in May-June of 1951. The results of this survey were first released at the meeting of the American Society for Engineering Education at Lansing, Mich., in late June, 1951. As indicated by Dean Hollister, this survey indicated needs far greater than those previously forecast and has consequently served to emphasize the need for drastic action in the conservation, utilization, and training of engineering manpower.

THE UTILIZATION OF ENGINEERS

Previous remarks have related to the existing and prospective shortage of engineers and scientists to meet the country's needs. The second great segment of the problem confronting us is proper utilization of the engineers available. For purposes of a review as to what has been done and the suggestion of a program for the profession this may be considered under three headings, namely:

(1) Engineers in private employment
(2) Engineers in civil government, national, state, or local
(3) Engineers in the armed services.

Of engineers in private employment a major portion are engaged in industry. The needs of various industries for engineers vary in accordance with the nature of the industry itself and to some extent—where engineering design or practice is not, strictly speaking, required—with the predilection of the individual employer as to the type of personnel and training which gives him most effective results. The nature of the activities of engineers engaged in sales, purchasing, and the like, varies so much from place to place that it is impracticable to make any sound generalization with regard to the justification for the use of engineers in such positions during an emergency such as now faces us. Two factors enter the situation. The first is that engineers who have been so employed for any considerable length of time probably now lack knowledge of the skills and techniques essential in the fields of design, development, and mechanical or chemical production, where our greatest needs exist. The second factor is that engineers who are nonessential in their present positions, whatever they may be, will probably be drained off into more essential engineering activities as the demand for their services makes itself felt.

It is the engineer properly engaged as such in private industry, along with his counterpart in the Armed Services, who is the critical figure in the present shortage. The young engineer is in many cases equally, sometimes even more, in demand than his more experienced confrere, for much of the technology now critically important is so new that only recent students have any training whatever in its application. A belief that the technical requirements of industry can be met by men generally over military age—even if there were enough of them—is therefore a fallacy.

As a means of assuring prompt integration into industry of newly employed engineers, with consequently more effective advancement and utilization of their skills, the Engineering Manpower Commission has urged upon industry the establishment of high-level training courses comparable to the hospital internships of the medical profession. Certainly, within industry itself, every effort must be made through training, reassignment, up-grading, and the like, to meet the present requirements. Steps of this nature can be made effective only by local action in individual industries. The pressure of scarcity probably will automatically lead to such measures in time, but preferably they should be initiated early to avoid the loss of production which otherwise will occur. Each of us probably has in mind some project or plant now suffering from a lack of engineering know-how which is available somewhere else. We cannot, in a free economy, reshuffle any group of private citizens at will; but employers of engineers must at least avoid the taint of hoarding unneeded technical employees in these times when a critical shortage in the over-all supply is evident.

With regard to engineers employed as civilians in governmental agencies, national, state, and local, certain steps have been taken upon initiation by the U. S. Department of Labor. The U. S. Civil Service Commission issued instructions to all Federal agencies regarding the development of a program for maximum utilization of engineering personnel with the Federal Government; and a program is under way to explore the possibilities of utilization of the engineering personnel of state, county, and municipal governments on a full-time or part-time loan basis to the Federal defense agencies and to other vital defense activities. This program, if it becomes effective, should be particularly helpful in the field of civil engineering.

The U. S. Office of Education has developed plans for a reactivation of the Engineering, Science, Management War Training (ESMWT) program followed during World War II for intensive, short-term courses in colleges and universities. This National Defense Training Program is designed to prepare persons for specific employment in defense-production establishments. All of the engineering schools and colleges have been requested by the Office of Education to co-operate in making available the services and facilities of these institutions, including part-time employment of engineering students and faculty members, to assist key defense industries urgently in need of such assistance.

The problem of the engineer and the Armed Services is an extremely difficult one. The proposed legislation which later led to enactment of the 1951 Selective Service Act at one time contained a provision for the exemption each year of 75,000 young men to enter technical and scientific training. This would include engineers, doctors, physicists, chemists, etc. The figure of 75,000 was a rough estimate of annual requirements arrived at without any real statistical attempt at accuracy. While this provision was pending, the President issued a Selective Service memorandum providing for the deferment of an indefinite number of college students conditioned upon class standing and record in a special examination to be given to applicants for such deferment. This created such a furor, based upon emotional rather than practical grounds, that Congress eliminated the proposed provision to permit 75,000 enrollment each year in scientific courses without interference by the draft, and the selective-service memorandum was modified to provide that results of the deferment examinations previously referred to should be considered by local draft boards as one factor in reaching a decision in individual cases. Furthermore, Congress, before passing the Act, and apparently because of the public outcry against exemption or indefinite deferment of any group, added a provision to the effect that deferment for *any* cause makes an individual subject to the draft until he reaches the age of thirty-seven. The justice of adding perhaps ten or fifteen years to the period of draft liability of a student deferred, say, for one year to complete his course, is questionable. But as the provision written into law applies to *all* deferments, including those for dependency, it cannot be considered on the basis of any one group. It is to be noted that in spite of this provision for extended liability to the draft, very considerable numbers of students applied for and took the examinations as a basis for application for deferment

The effect of Selective Service upon engineers—or prospective engineers—may be considered from the standpoint of two groups other than students. As to the deferment of engineers in defense industry, provisions for consideration of their cases have been set up in the various services, but the variations between services and the arbitrary action in many cases have been such as to cause considerable difficulty. No sound procedure has yet been evolved for proper determination of the value to the *materiel* aspect of the Armed Forces of an engineer in defense industry as compared to the value of the same man in uniform, where he might or might not be utilizing in his engineer training.

The later possibility—namely, that he might not be utilizing his engineering training—has seemed all too prevalent. The Commission has received notice of so many cases of this nature as to evidence a deplorable lack of policy for assuring that engineering and scientific skills among draftees are recognized as a basis for routing their possessors to assignments where such skills will be utilized.

The reservist problem has some of the same aspects—and some of its own. The Armed Services must be given credit for preserving records of the qualifications of their reservists, but the difficulty lies in the fact that in calling a reservist the services think of the qualifications of the individual as of six or more years ago. During that period many a young man, through the G. I. Bill or otherwise, has acquired a technical education and possibly practical experience as well. The young man who was a supply sergeant in 1945 may now be an electrical engineer with a couple of years' experience in electronic controls. The fellow who got his B.S. in the early forties and was a battery commander at the end of the war may now be a process engineer in a chemical plant. But those two men, if called back into service, are likely to be assigned as supply sergeant and battery commander, respectively.

Another difficulty lies in the wide gap—administratively—which separates civilian employees from uniformed personnel. This, as you know, exists within the Defense Department itself where, for example, the Engineer Board at Fort Belvoir was combing the colleges for young civilian engineers while some twenty recent graduates were among a group of draftees who had just arrived. The detail of draftees to other agencies, such as the Atomic Energy Commission, is surrounded with still greater difficulties.

Action in some individual cases, in recent times and during World War II, has been encouraging, but these are all too few. A proper over-all handling of the situation requires the development of an entirely new administrative routine with regard to individuals of special qualifications. The old policy of assignment according to availability must be improved.

Maintenance of superiority in weapons and in production is so critical to this nation that continued apparent indifference of the Defense Department to this situation is unthinkable. One of the several efforts to find the means of securing more consideration of the utilization of engineers was met with a reply essentially to the effect that the Armed Services would take what men they wanted and industry would get along with those who were left. The recent appointment under the chairmanship of Dr. Arthur Flemming of a Committee on Specialized Personnel promises a means of bringing more forcibly to the attention of the Defense Department the necessity of assigning technically trained men to technical jobs where their training is fully utilized. Otherwise our superiority in weapons will be lost.

A PROGRAM FOR THE ENGINEERING PROFESSIONS

The Engineering Manpower Commission, as now constituted, is sponsored by Engineers Joint Council. The Commission consists of three members of each of the five national engineering societies composing EJC, supplemented by three members from the American Society for Engineering Education—as is most appropriate in view of the student problem involved. Following similar objectives, a group from the American Chemical Society has just initiated "A Proposed Educational Program to Acquaint the American Public of the Role of the Scientist and Engineer and the Impact of Science and Technology on Modern Living."

The technology of our country is at a critical point. If we are to be the Arsenal of Democracy, we must out-design and out-produce our enemies. Our very survival depends on so doing. And to maintain military superiority—which may be necessary for a long, long time—we must continually keep ahead in technical achievement.

Aside from the military aspect, there is much reason to believe that while heretofore we have considered ourselves as living in the technological age, we have actually only been approaching that age. Recent advances in science have been so rapid that the engineer is challenged as never before. It is our function to translate these advances into means for the survival of our civilization and for an ever-improved standard of living. The engineer's role, his opportunities and responsibilities, are destined to become greater and greater as science continues its advance.

To play his part, each individual, particularly in this emergency, must so devote himself to his own task that the total engineering output shall not suffer by his deficiency. If an employer of engineers, he should see that his organization makes the maximum practicable contribution to the sum total of engineering requirements. As individuals and as members of local engineering organizations we must encourage increasing numbers of able young men to enter the profession.

The engineer must become articulate as to his work. Most of all he must continue to observe the high standards of professional ethics which dignify the profession. He must contribute his share of public service in the manner to which he is best fitted. His example should inspire young men of the land to follow in his footsteps in further advancement of the engineer's responsibility for direction of the forces of nature into the field of man's service.

IN HIS third quarterly report to the President, Director of Defense Mobilization Charles E. Wilson cited the work of the Science Advisory Committee of ODM on the use of scientific manpower.

To promote the best distribution of scientific personnel in the face of the current great demand, the Committee is attempting to assist university and college scientists to balance their normal research with the work which they do as part of the defense program.

The impact of the expanded defense effort has been mainly upon industry and Government laboratories, where the scientists are engaged in the practical application of the scientific advances of the last decade.

In the universities and colleges, the majority of scientists are still engaged in fundamental research and in the training of young scientists on whom we must rely for our future strength.

The Science Advisory Committee feels that this emphasis should continue, but at the same time a substantial portion of the academic effort should be applied to defense needs and also to build up throughout the academic community a widespread knowledge of the scientific problems of defense and a reserve of scientists to meet extreme emergencies should they arise.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

COMPILED AND EDITED BY J. J. JAKLITSCH, JR.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Iron and Steel Scrap

AIMED to help increase the current dangerously low iron and steel scrap inventories in this country, the National Production Authority, U. S. Department of Commerce, is distributing a booklet, "Scrap for Steel Mills and Foundries for Defense," to more than 200,000 executives of business, industry, and trade associations.

The book emphasizes that record-breaking steel production and large-scale expansion of production capacity have reduced scrap inventories of mills and foundries to a new all-time low, with some plants having only a few days' scrap supply on hand. If the nation is to achieve its 1951 goal of 110,000,000 tons of steel ingots and castings, 36,000,000 tons of purchased heavy industrial scrap must be found, the booklet says.

Following is the program outlined in the booklet for the recovery of dormant scrap:

1 Go after dormant scrap—start an emergency inspection and inventory of all heavy steel, whether machines, equipment, beams, or plates. Dispose of everything you possibly can to a scrap dealer.

2 Appoint someone with authority—it is extremely important that the top executive of every industrial and commercial establishment, large and small, appoint someone with authority to clean out dormant scrap and to be responsible for a continuous good-housekeeping job.

3 Salvage committee—in large industrial firms the chief executive should appoint a salvage committee with authority to make decisions. The committee should (*a*) search all plants and properties, regardless of size, for dormant scrap such as obsolete machinery, tools, jigs, dies, and other equipment, including items that are broken, dismantled, worn beyond repair, abandoned, or in need of parts that can no longer be obtained; (*b*) survey potential wrecking and dismantling projects that will produce scrap; (*c*) make disposition of all production and dormant scrap as quickly as possible.

4 Put scrap collection on a "housekeeping" basis—besides increasing the supply of iron and steel scrap, continuous scrap recovery from questionable old stand-bys, obsolete machines, and equipment reduces taxes through inventory write-off, improves safety conditions, gives lowered insurance rates, and clears valuable space. Make it the personal responsibility of the committee chairman to initiate a program that will clean out the dormant scrap from the plant. It is suggested that the committee make surveys not less than every 30 days. Make your organized permanent salvage program a top-management responsibility.

The booklet lists the groups taking part in the scrap-recovery program. Industrial and commercial firms, entire industries such as the railroads, petroleum, auto wreckers, industrialized cities, federal government agencies, and trade associations have already established salvage committees and programs. The Chambers of Commerce have assisted in organizing more than 800 local scrap mobilization committees of leading industrialists and businessmen.

NPA emphasizes that this is not the house-to-house type of scrap campaign carried on in World War II. It is, rather, directed at those business and industrial executives who have the authority to determine what can be scrapped, order the disposal through normal channels, and arrange to have obsolete equipment written off.

Cigar Chemistry

MECHANICAL engineers probably don't realize it, but when they sit down to enjoy that good cigar, a great deal of chemical problems must be solved before that cigar will satisfy. For example, if it contains too much magnesium, the ash will dribble down your vest. If the potassium is low, it will keep going out. If it has too small a percentage of organic acids, it will taste flat, but if the volatiles are too high it will taste sharp. If the sulphur content is too high, it will probably just taste badly. These and the points that follow are outlined by Merritt L. Kastens in the July, 1951, issue of *Industrial and Engineering Chemistry*.

According to the article, the tobacco plant is one of the most accommodating of cultivated plants. It will absorb almost any compound put into its soil. Consequently, modern tobacco farmers can control the inorganic chemical composition of their

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at the usual rate, 40 cents per page.

product almost as well as the producers of synthetic organic structures.

Of course, the organic constituents that account for 80 per cent of the leaf weight are determined by the type of plant and the growing conditions—factors over which the tobacco farmer has less control. Curing procedures will further alter the chemical nature of the organic components. However, within the basic framework of the organic structure, the modern grower can exercise a remarkable control over the smoking characteristics of his product by altering the inorganic portion of the leaf.

Because of its voracious nature, tobacco must be heavily fertilized. Applications of as much as 3 tons per acre are not uncommon, but the fertilizer formulas vary widely according to the properties desired in the leaf and the requirements of the soil. Over a ton per acre of organic matter, usually cottonseed meal or a pomace, is used for many cigar tobaccos. Tobacco stalks and stems may be used as a source of organic matter, but may reinfect the plot with plant diseases if not carefully plowed under. These materials decay in the soil, which acts as an intricate chemical kitchen to prepare the balanced plant food which will determine the color and feel of the leaf and furnish the organic acids that give it much of the flavor and aroma. However, these acids volatilized in the burning cigar will irritate the smoker unless they are neutralized. Application of potassium, calcium, and magnesium salts to the soil in balanced proportions insures an ash of alkaline oxides which will neutralize the acids. In cigar tobacco the total ash runs from 18 to 22 per cent of the weight of the dried leaf. In cigarette grades the ash averages about 15 per cent.

In general, the heavier the ash, the sweeter the smoke, but the mineral components do more than just produce an alkaline buffer, according to Mr. Kastens. Potassium in the dried leaf is present primarily as nitrate which decomposes on burning to provide the added oxygen required to keep the tobacco glowing after it has been lighted. Cigars contain the equivalent of 5 to 6 per cent K_2O. Cigarette tobacco requires only about half as much potassium nitrate, as the paper helps to support combustion.

If potassium were the only alkaline metal present in the ash, its fusion in the glowing zone at about 600 C would coat the carbonaceous materials with a layer impervious to oxygen and result in incomplete combustion, a black ash, tars in the smoke, and an unhappy smoker. Magnesium oxide is a fluffy ash which will not fuse at the burning temperature, so magnesium salts are added to the soil and hence to the leaf, so that enough magnesium oxide is present to break up the potassium oxide glaze and assure access of oxygen to the combustible materials. Too much magnesium, however, will make the entire ash flaky and it will tend to dust off on your best blue serge, Mr. Kastens states.

Consequently, the potassium-magnesium balance must be closely controlled. Even if the potassium-magnesium balance is correct, it will not produce the firm persistent ash that is the delight of smoking connoisseurs. This requires the presence of calcium oxide to provide a spongy coherent deposit. These three alkaline metals are major significant cations in tobacco. It has been claimed, however, that tobacco from fields that have been used for long periods for this crop gradually loses its characteristic flavor. Such deterioration might be caused by exhaustion of trace minerals, but this reasonable theory has yet to be proved.

Anions, too, contribute to the quality of your after-dinner smoke, states Mr. Kastens. The nitrogen content determines the color of the natural dried leaf. The golden cigarette tobaccos are produced through deliberate nitrogen starvation of the growing plant. The 30 to 40 lb of nitrogen per acre they receive are the minimum permissible for a reasonable yield. The more robust-hued cigar tobaccos get nearly ten times as much.

Nitrogen starvation means the elimination of nitrate salts. However, some anion must be associated with the cations necessary for a high-quality product. Phosphates are absorbed too slowly. Bromides are absorbed the most rapidly, but they seriously inhibit burning. Carbonates are too alkaline, and cannot be used excessively. Sulphates tend to decompose and impair the flavor and must also be minimized. Furthermore, the excess sulphate precipitates as calcium sulphate needles which produce a smooth close texture that does not burn properly. Calcium normally precipitates as the oxalate in cubic crystals which give the leaf a slight pebbly grain and a greater burning surface. Chloride is the anion usually used. It has high absorbability, and although it inhibits burning it seems to have no effect on the plant metabolism—in fact, it aids drought resistance in nitrogen-starved tobaccos. Cigarette tobaccos contain a small (less than 1 per cent) percentage of chlorine as chloride.

Chlorides are also sometimes used when nitrogen is fed to the plants as ammonium ion in seedbeds. The ammonium ion, when associated with large complex anions, may not penetrate the tobacco root, but will concentrate in the root coating. Halide ions will dislodge the ammonium ions in such cases and translocate them into the root sap, and ultimately to the tobacco leaf. Chlorides are never used in cigar tobaccos. However, as nitrate may be used freely on this crop, there is no need for a substitute anion.

Where it is desirable to exclude all absorbable anions from the tobacco bed, granite stone meal may be used as a source of potassium, according to a recent suggestion by R. R. Swanback of the Connecticut Agricultural Experiment Station. He has found that nitric acid produced by nitrification in the soil and the carbonic acid evolved by the tobacco roots will enable the plant to absorb adequate potassium from granite meal where it is present in a silicate complex with aluminum. The discovery may well afford a cheap potassium source for other crops as well as tobacco.

Whether it does or not, writes Mr. Kastens, the next time you "walk a mile" or "take a treat instead of a treatment" give a moment's thought to the tobacco farmer diligently juggling his ions as he drives the manure spreader. And, he says, you might give another moment's thought to the possibility of a science-minded politician declaiming that "what the country needs is a good five-cent cigar with sufficient potassium and calcium, not too much magnesium, a minimum of sulphate and chloride, and plenty of organic acids."

Rubber-Filled Propeller

AN airplane propeller filled with sponge rubber is now in manufacture at the Hamilton Standard Division of United Aircraft Corporation. Light as a feather, bone hard, and strong, the hard sponge is used to fill the void between propeller-blade core and shell, keeping the latter from vibrating in and out under extreme pressures, and supporting it against the impact of rocks, ice, and other material thrown up by the plane's undercarriage.

The new filling compound, called HS 160, has three principal components; Hycar OR-15, an oil-resistant rubber manufactured by B. F. Goodrich Chemical Company, phenolic resin, and nylon. The blowing agent used to foam this rubber-resin blend up to eight times its former mass is the highly reactive chemical, azodiisobutyronitrile. After foaming under 300 F, the compound cools into a light rigid structure which fills

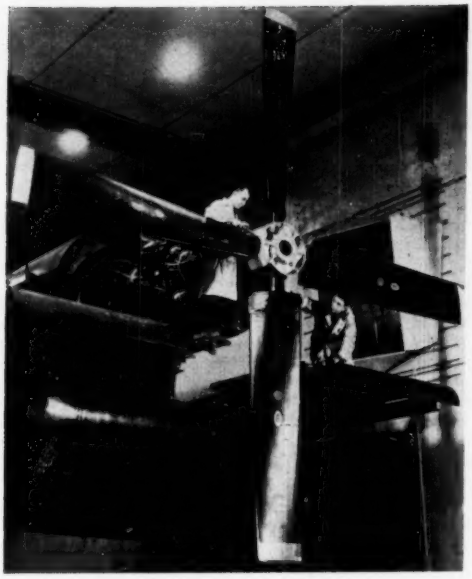

FIG. 1 A SPECIAL SPONGE-RUBBER FILLING KEEPS THIS PROPELLER-BLADE SHELL FROM VIBRATING IN AND OUT UNDER EXTREME PRESSURES AND SUPPORTS IT AGAINST THE IMPACT OF ROCKS, ICE, AND OTHER MATERIAL THROWN UP BY THE PLANE'S UNDERCARRIAGE

every portion of the aperture between propeller core and blade edges, and the hollow core itself. HS 160 has been so compounded that high centrifugal loads will not cause it to shift after its installation.

Blending of Hycar Nitrile rubber with compatible resins, like phenolic, is not a new concept. Phenolic resins are inherently strong, hard, but relatively brittle mass condensation polymers of phenols and aldehydes. Hycar rubber is soft, extensible, tough, and extremely adaptable. The blended product, combining the advantageous properties of each, is therefore hard, strong, and extremely tough.

Canadian Oil Developments

THE development potentialities of the Alberta oil fields in Canada were discussed by Dr. O. B. Hopkins, vice-president, Imperial Oil Ltd., Toronto, Canada, before a Railroad Division technical session at the 1951 ASME Semi-Annual Meeting in Toronto.

Dr. Hopkins pointed out that it was not until Imperial Oil completed its 134th wildcat well at Leduc in February, 1947, that the expected large reserves became a reality. Leduc and the adjoining Woodbend pool are estimated to contain some 200 million bbl of recoverable crude oil, not far short of twice the total recoverable reserves from the historic Turner Valley field.

The discovery of this large reserve in a setting that was known to be generally favorable to the accumulation of oil, and in an area where crude oil was so much to be desired, initiated a tremendous wave of exploration. In 1947, the year of the Leduc discovery, expenditures on exploration and development in western Canada had been in the neighborhood of $15 million. In 1948 the figure rose to $50 million; to $100 million in 1949; $150 million in 1950; and currently the expectation is that some $200 million will be spent during the current year.

In the field these expenditures were reflected in an increase in the number of geophysical survey parties from 15 in 1946 to 123 such parties in 1950. Wildcat or exploratory wells increased from 75 in 1947 to 261 in 1950. Last year alone, 1017 wells were completed involving over 2.9 million ft of drilling—or some 530 miles.

The wave of exploration since Leduc has resulted in the discovery of a number of new fields and the addition of more than a billion barrels of oil to Canada's petroleum reserves. Leduc had not only broken the long sequence of disappointing exploration efforts, but by disclosing oil in Devonian formations it had given the oil prospector a new horizon to shoot for. Before that time, Canada's discoveries had been found mainly in the Rundle limestones of Turner Valley and in the lower cretaceous sands as at Wainwright, Vermillion, and Lloydminster. The recent discoveries are largely in the Upper Devonian formations, and interestingly enough it is these same formations which are overlaid by the famous tar sands along the Athabaska River.

But of the new discoveries, one field was of exceptional importance. This was the famous Redwater discovery some 35 miles northwest of Edmonton. The first well in this field was completed on August 31, 1948.

In its way, Dr. Hopkins said, the Redwater discovery was almost as important as the find at Leduc. The current estimate of Redwater's recoverable reserves is put at some 500 million bbl and the discovery of this field in 1948 indicated conclusively that the prairies would have more than enough oil for western needs and that markets beyond the prairies would have to be sought.

Australian Oil Shale

HOW Australia has been producing motor gasoline and allied products on a commercial scale from native shale is described in a Bureau of Mines report released recently by the Department of the Interior.

Two Bureau technologists visited the plant and mine of the National Oil Proprietary, Ltd., at Glen Davis, New South Wales, in September, 1947, in connection with the oil-shale phase of the Bureau's synthetic-liquid-fuels program. The report is based upon their observations supplemented by laboratory tests of Australian oil shale and shale oil.

Commercial oil-shale development in Australia apparently began in 1865, the report notes, with kerosene, candlewax, and oil for improving the illuminating quality of manufactured gas the chief products. The early plants were abandoned and are now in ruins, as they were not suitable for producing the products now in demand.

The Glen Davis plant began operations early in 1940. The shale there is in three seams with a maximum thickness of seven feet. At one face only a single two-foot seam is exposed. The mine is operated by the room-and-pillar method, like a mechanized coal mine, and production averages 8½ tons a day per face worker or three tons per mine employee. The main seam has a Fischer assay value of about 140 U. S. gal a short ton and is probably the richest oil-shale seam being mined in the world.

The report says that the daily output of 400 tons of shale could be increased if a larger mining force could be obtained. The retorts and refinery could handle twice the shale processed in 1947, it adds.

The mine, the retorting plant, and the refining equipment are described in detail. Photographs, diagrams, and tables supplement the text, which includes considerable historical material dealing with the development of Australian oil-shale reserves.

The principal product being marketed at Glen Davis is motor gasoline having a motor method octane rating of 70 to 71 with 1.25 milliliters of tetraethyl lead a gallon. Small quantities of liquefied petroleum gases, cresols, and cracking-still coke are marketed, and fuel gas and oil are supplied for generating process steam and power at the plant.

A free copy of Report of Investigations 4796, "Oil-Shale Operations in New South Wales, Australia," may be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa.

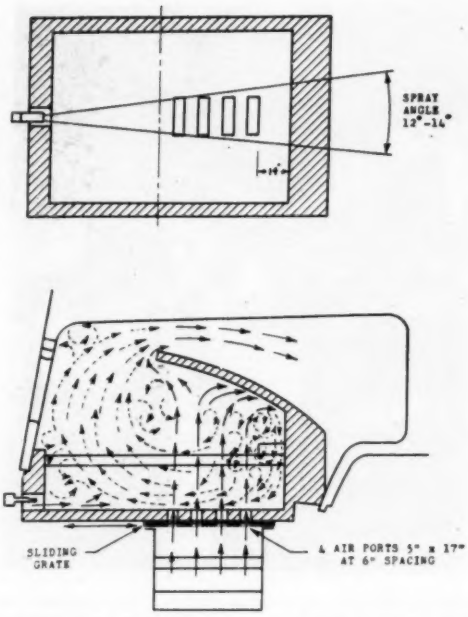

FIG. 3 FIREBOX UTILIZING SLIDING-TYPE PLATE DAMPER NOW UNDER STUDY IN CANADA

Oil-Burning Locomotives

THE experience of the Canadian Pacific Railway with oil-burning equipment as applied to steam locomotives was outlined by W. A. Vanderland, research engineer, Canadian Pacific Railway Company, Montreal, Canada, at a Railroad Division technical session, during the 1951 ASME Semi-Annual Meeting, in Toronto, Canada. He dealt primarily with the design of the combustion system and gave information on the function of its component parts as developed through cooperative studies conducted by the Railway and the National Research Council of Canada.

Prior to 1911, Mr. Vanderland said, the Canadian Pacific Railway operated coal-burning locomotives on the heavy main-line grades through the Canadian Rockies. Because of the fire hazard created by excessive spark emission and the costly fire patrols thereby involved during the summer months, a program of conversion from coal to oil burning on the Mountain Subdivision was begun in 1911. By 1914 there were 134 oil-burning locomotives in this territory. At the present time, approximately 264 are in service.

Oil-burning locomotives fall into two general classes, designated as either front or back burners, depending on the burner location in the firebox. The former arrangement is widely used by United States railways, while the latter design has been favored by the Canadian roads. A burner of the drooling or outside-mixing type has been found satisfactory. Of this type, the one most commonly used is the Von Boden burner. This design is simple and rugged and since only gravity feed is required, it has proved very dependable for locomotive service. The most favorable characteristic of this type of burner is its high capacity and ability to function satisfactorily over a wide range of loads, which on a locomotive may vary from 40 to 750 Imp gal of oil per hr.

The oil-burning design used by different railways varies considerably. Combustion air may be inducted through openings in the floor, around the burner, or in the fire door, any of which may be damper-controlled. The majority of roads which favor the location of the burner at the throat sheet do not use a brick arch. With this design, the most common

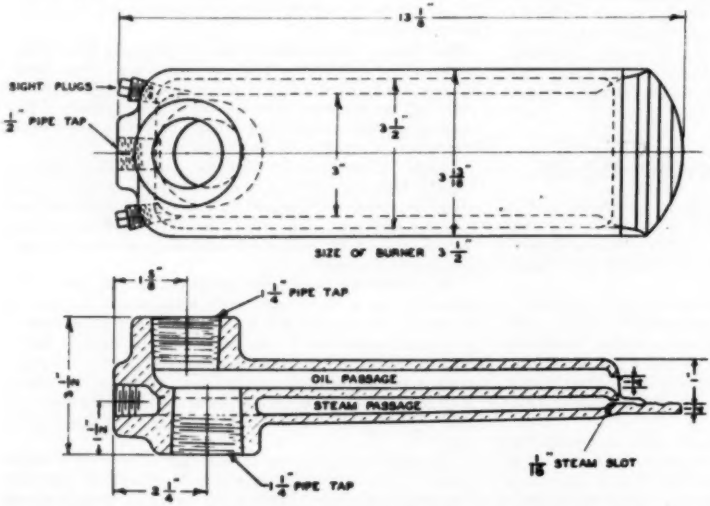

FIG. 2 VON BODEN-INGLES OIL BURNER—MOST COMMONLY USED BY THE CANADIAN ROADS

arrangement of air inlets is an opening around the burner and an opening in the floor close to the flashwall, which is located at the back of the firebox, both openings usually having damper control.

The combustion arrangement on the early Canadian Pacific locomotives was modeled after designs incorporating front burners. Serious maintenance problems arose with engines equipped in this manner and comparative tests were therefore carried out to determine the suitability of placing the burner in the back position, firing toward the front of the firebox. The results were very satisfactory and led to the development of the present standard arrangement using a back burner, admitting primary air at the burner, and secondary air through a grid in the floor below a brick arch.

It was found that locomotives equipped with front burners had a high incidence of stay-bolt failures which was most serious on the side sheets near the face plate and across the back sheet. In addition, cracking of the corners of the face plate was common. These failures were attributed to unequal expansion of the sheets since the flame had an opportunity to impinge directly on the back sheet. The back sheet was also subjected to sudden cooling whenever the load was decreased since it was normal practice to admit secondary air through a floor opening at the back of the firebox. In the case of a back burner, the incoming air is heated by the hot arch bricks before circulation, resulting in more uniform temperature distribution.

Metal Treating

A NEW metal-treating chemical process which greatly extends lubrication limits in the cold-working of steel has been announced by the Pennsylvania Salt Manufacturing Company, Philadelphia, Pa.

Designated as the Pennsalt Foscoat process, it consists of compatible cleaning, pickling, and application of a new phosphate coating and specially developed lubricants to steel. A heat-resistant lubricating surface is produced which is chemically interlocked with the steel and, therefore, possesses exceptional adherence even under the most severe working conditions.

It was to improve earlier German work in cold extrusion that the new phosphate coating chemical bath was developed by researchers of the Heintz Manufacturing Company of Philadelphia. Joint research conducted by Pennsalt and Heintz has resulted in the evolution of the carefully integrated Foscoat metal-preparation process.

Of immediate importance to industry are the remarkable results which have been attained in such applications as tube drawing, wire drawing, deep drawing (ironing), deep stamping, cold kneading, and similar cold-working operations.

In these operations there generally exist two limitations—lubrication and the ductility of the metal. The former limitation is virtually eliminated by the chemically bonded lubrication film imparted to steel surfaces by the new process.

Significant economies resulting from this improvement in lubrication include elimination of intermediate press operations, as well as annealing and chemical-treating operations; additional reduced consumption of chemicals because of compatibility; increased production with existing equipment; savings in metal or reduction in scrap losses; and considerable extension on the life of costly dies.

In wet-drawing of fine steel wire, for example, commercial application of the Foscoat process resulted in a 40 per cent increase in the rate of production—actually to the highest rate of capacity of the drawing equipment. Despite this speed-up, die life was increased $2^1/_2$ times. In dry-drawing of steel-wire shapes, such as triangular and square wire, from round stock, one application of this method permitted drawing to finished shape without the intermediate anneals and recoating required in previous processes.

Production use of the Foscoat process at Heintz Manufacturing Company has made possible substantial economies in the fabrication of automatic washing-machine tubs. Reductions in scrap losses due to rejects and in downtime for stoning of dies have resulted in an increase of 140 per cent in output.

In deep drawing (ironing) of steel cartridge cases, 80 per cent reductions in wall thickness in the metal were possible with a single application of the Foscoat process without intermediate annealing. This represents a 100 per cent improvement over conventional practice.

In actual production in rod-pulled tube drawing, over-all reductions of 80 per cent were achieved with a single application of the process, or about 60 per cent improvement over that previously obtained. In another tube mill, using plug drawing, over-all reductions of 60 per cent were obtained with one application of Foscoat, which is also a 60 per cent increase over existing practice.

Even more dramatic savings are in prospect in commercial cold extrusion, for it can often eliminate the necessity for forging or upsetting of heated billets. These operations generally require a starting billet twice the size of that necessary for cold extrusion. The forged shape usually requires extensive scrap-generating machining.

Foscoat itself is a specially formulated phosphate coating which can be applied by immersion, flooding, or spraying, and

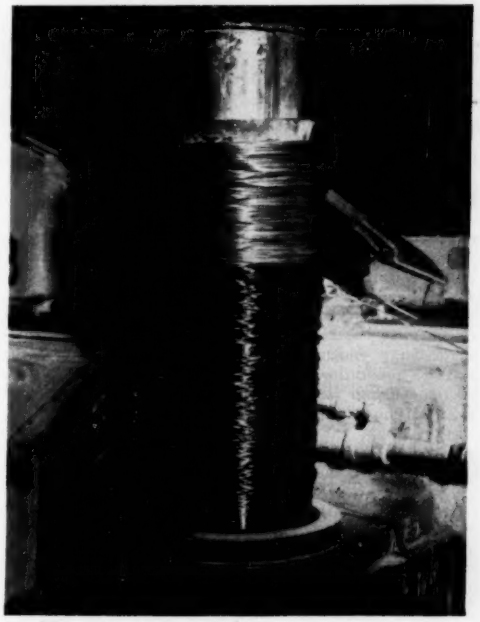

FIG. 4 SURFACE FINISH OBTAINED IN A LARGE WIRE MILL, USING FOSCOAT PROCESS LUBRICATION, AS COMPARED WITH FORMER CONVENTIONAL LIME PRACTICE

(The uniform, dark-colored, scratch-free surface is vastly superior to the shiny, nonuniform scratched surface resulting from use of lime.)

FIG. 5 USE OF FOSCOAT PROCESS IN DEEP-DRAWING STAMPING AT HEINTZ MANUFACTURING COMPANY IS SHOWN BY THIS TWO-STEP PRESS OPERATION IN PRODUCTION OF AN AUTOMATIC WASHING-MACHINE TUB

forms a strong adherent coating chemically bonded to the steel. This highly adsorbent coating functions as a host for Foslube, an organic lubricant which is designed to react chemically with the Foscoat, in addition to being physically adsorbed and absorbed. The combined action gives a heat-resistant surface interlocked with the metal and which has exceptional adherence even under the most severe working conditions.

In view of the importance of proper precleaning and preparation for cold-working, the complete process was worked out to include pickling and special alkaline cleaners, designated as Fosclean products.

This is a distinct advantage to plant users in that Pennsalt, which has formed a new sales group for this purpose, is able to supply a complete integrated process with all necessary chemical ingredients as well as technical service for the entire cold-working operation.

The technical service phase includes layout and equipment design as well as mechanical-engineering service on tool-and-die design to insure optimum performance made possible by the superior lubrication obtainable with the Foscoat process. Heintz engineers are co-operating with Pennsalt in the latter phases of this service.

Engine Indicator

A CONDENSER-TYPE engine indicator, adaptable for recording pressures as high as 20,000 psi and as low as the minute force of blood in a human vein, was described recently by John W. Leggat of General Motors Research Laboratories, before the National Instrument Conference, Houston, Texas. Mr. Leggat detailed the versatility of this type of equipment in research on automotive engines, fuels, transmissions, hydraulic steering mechanisms, and other industrial problems.

The indicator is even used to measure vibration characteristics of an aircraft turbine blade at speeds up to 12,000 rpm and at temperatures up to 1500 F.

Mr. Leggat explained that work with pressure indicators dates back to the early days of the GM Research Laboratories during the pioneer studies on the problem of engine knock and the use of tetraethyl lead as an antiknock additive to fuels.

Several types of indicators have been developed since that time, he said, and their application has extended to laboratory projects far afield of engine-fuel research.

The present condenser-type indicator consists of a pickup that can be screwed into the head of an automotive engine. The pickup is connected to an electronic oscillator. Changes in engine combustion-chamber pressures cause changes in the indicator's electric circuit, similar to the circuit capacity changes in a radio when it is tuned.

Such changes are visible on the screen of a cathode-ray oscilloscope by means of an electron beam tracing line.

The line traced on the screen is a graphic illustration of the pressure changes in an engine cylinder during a complete cycle of operation. This pressure record can be plotted against time or the engine crank angle.

Mr. Leggat said that not only is the indicator capable of recording extreme pressure changes, such as those in high-compression automotive or Diesel engines, but also is adaptable to the measurement of such small motions or vibrations as those occurring in the mechanism of an automotive clock.

He expressed the hope that knowledge of the capabilities of this type of indicator will help laboratory workers with measurement problems in research projects both within and outside of the automotive and mechanical fields.

Plating Plastics

PLATING metal on Bakelite and Vinylite plastics by a new and economical method is said to make possible lightweight corrosion-resistant products with hard high-polish metal surfaces. Metal-plated plastic items cost less to ship than solid metal, are more resilient, lighter to carry, and are highly resistant to heat, abrasion, and weathering. New ap-

plications for metal-plated plastic articles are particularly useful for replacing metal parts in airplanes, trains, autos, luggage, and handbag accessories.

Mass-production techniques, developed by Plastiplate Company, Inc., South River, N. J., deposit a hard film of copper, silver, chromium, or other metal 0.002 to 0.003 in. thick on the surface of small plastic articles. Instrument control knobs, jewelry, bottle caps and closures, novelties, and hardware are only a few of the items molded of Bakelite phenolic or styrene plastic which have been given an attractive, durable metal-plate finish by this process. In still another application, copper is plated on an object molded of Vinylite plastic—such as a doll arm—to make a new mold for slush molding the identical object with Vinylite resin plastisol.

Twelve different colors as well as natural metal finishes can be plated evenly and to any desired thickness on Bakelite styrene and phenolic plastics, it is claimed. Because of the high degree of control exercised during this mass electroplating process, even two colors can be plated on inner and outer surfaces of a single deep-molded plastic object to produce a unique inlay effect.

Sandblasting or wet and dry tumbling of the molded plastic object are the first of four basic steps of the electroplating process. This abrasive surface treatment roughens the smooth molded plastic object to promote adhesion with the metal plating. As most plastics do not conduct electricity, a conductive bond coat must then be applied. Dipped for a minute or two in a sensitizing solution and rinsed, the plastic article is then given a thin bond coat of silver 0.00001 in. thick by chemical reduction in a spraying or immersion operation. When dry, the bond coat is tested for electrical conductivity; 0.25 to 5 ohms is considered satisfactory.

Large numbers of roughened bond-coated plastic items are then put in perforated barrels made of laminated plastics. These barrels revolve in a copper salt solution. Copper anodes furnish ions to the solution and these ions migrate through the barrel's perforations to plate out on the objects tumbling about inside. Contact for the cathode connection is made through the bottom of the barrel which is insulated from the solution by the high resistivity of the Bakelite phenolic.

About 12 hours in the barrel are needed to build up a base coat of copper plate 0.002 in. thick on the plastic surface. A

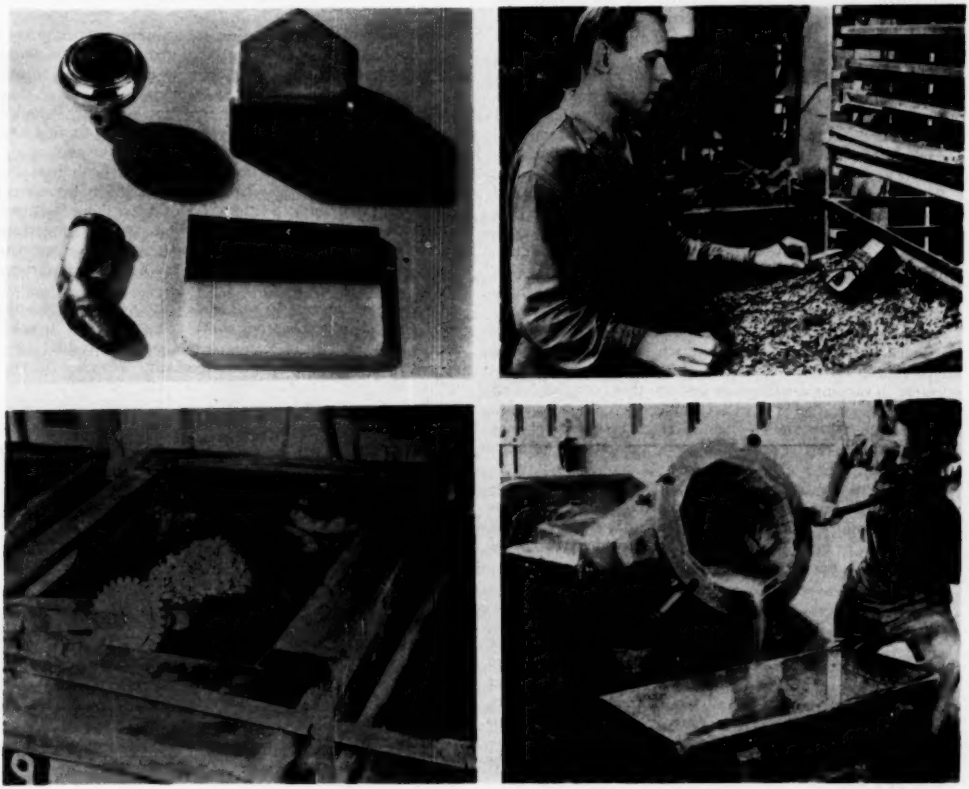

FIG. 6 PLATING METAL ON ITEMS MOLDED OF PLASTICS

(*Top left:* Hardware, jewelry, bottle closures, molds for slush molding doll parts, and shielding for electronic circuits are some of the plastic items that can be electroplated. *Top right:* Bond coat is tested for electrical conductivity. *Bottom left:* Objects are electroplated by tumbling inside a perforated barrel revolving in a copper salt solution. *Bottom right:* Plated objects are polished by tumbling them in barrels filled with steel shot and soap solution.

thin finish coat of gold, silver, chromium, nickel, brass, lead and other metal or color is then plated over the copper base in another electroplating barrel to give the article the desired finish.

The strength and lightweight of Bakelite and Vinylite plastics is said to make possible the fourth and final step of mass polishing the small plastic articles economically in tumbling barrels. The metal-plated plastic article bounces resiliently in revolving barrels containing steel shot and soap solution. Large objects, such as the molds for slushing molding doll parts, are copper-plated in long copper still tanks and polished on buffing wheels. Gold, silver, and copper-plate finishes are usually given a final coat of clear lacquer for added protection.

Synthetic Lubricant

A SYNTHETIC grease has been developed which operates satisfactorily on antifriction-bearing surfaces and light to moderately loaded gears and screw mechanisms in temperatures as low as —100 F, according to the CADO *Technical Data Digest*, September, 1951. Research on the project was initiated in January, 1950, by the Petroleum Products Branch of the Materials Laboratory, Research Division, Wright Air Development Center.

The goal was to develop a lubricant which would function at high altitudes on equipment with low starting torque, without imposing any loss in the life of the equipment as lubricated with standard AN greases. Lubricants being used became stiff and prevented such equipment, as for example a $^1/_{100}$ hp motor, from working properly.

Preliminary data covering operation of lightly powered mechanisms lubricated with greases made in the Materials Laboratory indicated it was possible to manufacture a —100 F grease using selected diesters. The data indicated also these materials might even meet MIL-3278 (formerly AN-G-25) requirements, and be suitable under conditions approaching boundary lubrication.

A proposed specification was submitted to industry, which responded by doing additional research and then submitting samples for evaluation. The Navy Bureau of Aeronautics cooperated in running qualification tests on these samples. One of the samples evaluated successfully met the proposed specification requirements, and the manufacturer has indicated that it will be commercially available. It is a material with a diester oil base.

Though this grease does not give as much life at high temperatures as do current greases, it is expected to find considerable use. Engineers point out that conditions brought about by operations at high altitudes have increased the problems of researchers in lubricants.

High-Speed Portable Boiler

A NEW boiler for a mobile shower unit for front-line troops which, it is believed, can heat more hot water faster than any unit of its weight and size in the world, has been developed by the U. S. Army Quartermaster Corps. This boiler, made of stainless steel, is part of a self-contained two-wheel trailer unit that is compact and light enough to be towed by a jeep.

Soldiers in Korea have been getting hot baths from this piece of equipment in shower water that is not only warmed to a comfortable temperature, but also specially heat-treated for their health and safety.

Water around battle areas, even when it looks clean and pure, is likely to be loaded with bacteria. Polluted water carries a constant menace of diseases like typhus. Furthermore, in many tropical countries parasites like the dread schistosome inhabit water supplies, ready to enter the body through any superficial cut or wound. Heat-treatment renders such microorganisms and bacteria harmless.

The mobile shower unit works as follows: The trailer is parked by any convenient pond or stream. A flexible suction hose is hooked up and its end thrown in the water. Another flexible hose goes to a level well-drained spot nearby where shower pipe sections are erected. When everything is set up and connected, 24 shower heads are ready to spout water from the overhead shower pipes.

A gasoline engine in the trailer unit is then started up, the burners in the stainless-steel boiler start to fire, and, within 20 min or less after the trailer is parked, hot baths are ready and running.

The boiler itself is about 7 ft long and a little over 2 ft in diam. Its burners can handle any liquid fuel from number 4 burner oil to 100-octane gasoline. The amount of heat that the boiler puts into the water can be as much as $2^1/_2$ million Btu per hr. This is enough to heat 25 ordinary homes in midwinter.

Water is heated in the boiler to scalding temperatures—just a few degrees below boiling. For about 20 sec the water is kept this hot. During that short time, dangerous organisms in the water are killed or rendered harmless.

After heat-treatment, part of the scalding hot water is cooled by incoming raw water. However, there is no mixing and the heat-treated water is not contaminated. The cooling occurs in two stainless-steel heat exchangers. Each heat exchanger is a boilerlike vessel that contains 250 stainless-steel tubes, $^1/_2$ in. in diam × 6 ft long. Hot water flows back and forth through these tubes while cool water surrounding them soaks up heat. While it cools treated water, the raw water gets warm, and it is then fed into the boiler with a good start up the temperature scale.

An automatic mixing valve blends scalding water from the boiler and cooler water from the heat exchangers. It takes just the right amount of each to regulate output at $102^1/_2$ F—the perfect temperature for a shower bath. Whether the suc-

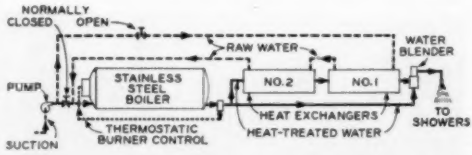

FIG. 7 SCHEMATIC DIAGRAM OF WATER CIRCULATION IN THE MOBILE SHOWER UNIT

FIG. 8 OVER ROADS OR OPEN COUNTRY—WHEREVER A JEEP CAN TOW IT—THE MOBILE SHOWER UNIT GOES TO THE SOLDIERS IN THE FIELD

FIG. 9 SET UP AND OPERATING BESIDE ANY STREAM OR POND, THE PORTABLE SHOWER UNIT PUTS OUT 24 JETS OF COMFORTABLY WARM HEAT-TREATED WATER

tion hose is in a tepid 80-deg pond or among broken ice cakes in a frigid river, the shower water always comes out at the ideal comfortable temperature—automatically.

Using a critical material such as stainless steel for the boiler and heat exchangers was not in the original plans. However, a tremendous heating and heat-transfer capacity had to be packed into a very small unit. Parts had to be small—so small that mechanical cleaning was impractical. And operating with all kinds of water—hard, soft, muddy, or swampy—the problems of cleaning and descaling had to be faced. With stainless steel, these problems are solved by flushing out the tubes with 20 per cent nitric acid, a treatment that would corrode most other materials. The service life of the unit, under this kind of care for the stainless steel, is estimated at about 1000 operating hours. The next best boiler and heat-exchanger material would have yielded only 250 operating hours.

Low-Cost Gas Plant

A REVOLUTIONARY low-cost gas-producing plant, so versatile that it can make city gas ranging in heat content from 300 Btu to 1050 Btu (the equivalent of natural gas), has gone into production at the east plant of Rochester Gas & Electric Corporation, in Rochester, N. Y.

Built as a demonstration unit, the new plant is designed to produce more than one million cu ft of city gas per day and can use gasoline, propane, butane, light oil, or natural gas as raw materials. Known as the Koppers-Hasche process, the plant was built by the engineering and construction division of Koppers Company, Inc., which has world patent rights for this type of installation granted by Dr. R. Leonard Hasche, the chemical engineer who invented it.

J. Hawley Taussig, Jr., manager of the gas department of Koppers, said that the Koppers-Hasche process, which is based on either thermal or catalytic reforming, gives the nation's gas industry the first low-cost unit for either the reforming of natural gas or the making of a gas which can augment natural gas at periods of peak demand.

With present high costs it frequently is impractical for utilities to deliver straight natural gas to customers even when it is available in their areas, because millions of dollars would be required in many cases to convert meters and fixtures in homes to the use of such gas, Mr. Taussig said. With this process it appears that natural gas may be reformed in such a manner that it can be delivered to homes with a Btu content comparable with past practice, yet costs may be reduced because the process produces substantially more of the lower-Btu gas.

But in areas where straight natural gas now is used, this process provides a means of making gas of comparable Btu content during periods of peak demand or when a break in the line cuts off supply, Mr. Taussig continued. This is because the process can deliver gas of the same characteristics and heat content that will mix readily with natural gas and burn satisfactorily in fixtures adjusted for natural-gas use, he said.

While the Koppers installation, built in co-operation with Rochester Gas and Electric, is aimed at solving some of the burdensome problems in production of a usable city gas, the Koppers-Hasche process is being given avid attention by the chemical industries.

This is because with only minor changes in raw materials or production procedures, the process can be made to synthetically produce benzene, ethylene, and acetylene—all chemicals now greatly in demand in the plastics and other industries. For instance, benzene and ethylene are major ingredients of polystyrene, the most-used plastic, while acetylene may be extensively used in making the new synthetic fiber, Orlon.

Present patent rights assigned to Koppers cover engineering and construction of the Koppers-Hasche plants for use by gas utilities, and Koppers is presently negotiating for rights to build the plants for production of benzene, ethylene, acetylene, and other chemical production.

In the Hasche process, the various chemicals are produced chiefly by varying the operating temperature, thereby setting up certain chemical reactions which change the molecular structure of the raw materials used.

The Koppers-Hasche process is particularly appealing to the gas and chemical industries because of its simplicity and subsequent low cost, Mr. Taussig said. Although the Rochester installation just completed is only a demonstration plant, it is estimated that a full-scale plant, capable of producing sufficient gas for the entire city, could be constructed at far less cost than any other process.

Heart of the Koppers-Hasche process is a thermal reforming furnace which may operate at varying degrees of temperature up to, and even above 2200 F. For producing city gas it is operated in the 1500 to 1600 F range.

In the Rochester installation, as it is presently being used, natural gas comes in from a large main, pressure is reduced to 5 psi, it is metered, and then flows through a valve which regulates its rate of flow. From here it goes to a mixing chamber where it is combined with air in a normal proportion of 1 to 1. This mixture enters the furnace for treatment.

Inside the furnace is a core of checker tile 9 in. wide and 20 in. high, divided in the center by a reaction chamber in which a catalyst may or may not be used, depending on the type of gas

to be produced. Surrounding this core is 4½ in. of high-duty refractory brick, a like thickness of insulating brick, and a steel shell ½ in. thick. The gas and air mixture flows for one minute into one end of the 20-ft-long furnace, then for one minute at the other end.

As the gas passes over the heated brick, the chemical change takes place and outlet pipes lead the reformed gas to a cooling tower and ultimately to gas-storage holders. Pressure generated in the process eliminates the need for exhausters. Careful control of the process is had at all times through a special control panel which records temperatures, rates of flow, pressures, and analyzes the gas mixture. Once in operation the unit needs only periodic checking by one operator.

The Rochester unit occupies a space only 42 × 21 ft and, except for the cooling tower, is less than 10 ft high.

Waste-Gas Utilization

GASES now wasted in coal mining may eventually be utilized in producing power, with the aid of turbines similar to those used in jet aircraft, according to Sir Alfred C. G. Egerton, professor of chemical technology at the Imperial College of Science and Technology of the University of London. He spoke before a group of college and university professors of chemistry and chemical engineering who were attending a conference conducted by the General Electric Company at Lenox, Mass., recently.

When coal is mined, he explained, some of the coal's energy escapes as methane gas. Though this is only about one per cent of the total energy, he added, it may still be a large amount of power, and if it could be utilized, it might be able to supply a large part of the power required in the mine.

Present methods sometimes employed, of burning some of the gas under boilers to make steam, salvage only a fraction of the energy that is now wasted, Sir Alfred explained.

He suggested that a gas turbine might provide part of the solution of the problem.

In the method proposed, some of the air pumped into the mine for ventilating purposes would be preheated to a temperature at which methane would burn, and thus, when mixed with the gas, combustion would take place. Then the hot gases would drive the gas turbine. The hot exhaust would be used to preheat additional air needed for the burning process.

He explained that whether this would be feasible depends on whether the methane would burn rapidly enough, and for that reason his laboratory has conducted experiments on the rate of burning of very fast-moving streams of methane and air.

It was found that if air and methane, at a concentration of five per cent, are separately heated to about 1800 F, burning takes place about 0.005 sec after they are mixed, which is rapid enough to allow use of the method.

He described other important researches on various phases of combustion being carried on in his laboratory. Explaining the reasons which have led to such great interest in these studies, he cited, "The combustion of fuels and improved efficiency of engines, the better understanding of knock, which limits the power of a spark-ignited engine, the improvement of gas heating appliances, the gas turbine, and the rocket with all its new problems needing the marriage of aerodynamics and combustion chemistry."

All this has proved a utilitarian urge for more intense research in this branch of chemistry, he said.

He added that 1400 million tons of coal and the equivalent of another 800 million tons, as oil and natural gas, are used by man every year. This is a total of 2200 million tons, of which 1800 million are not usefully applied.

Visual Metal-Cutting Study

BASIC studies of the metal-cutting process made by Nathan H. Cook, instructor, department of mechanical engineering, and Milton C. Shaw, associate professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass., have revealed that metal is truly removed by a single-point tool by a process of shear. In analyzing the cutting process it is commonly assumed that all of the shear strain to which a chip is subjected occurs as the metal crosses a so-called "shear plane" that extends from the tool point upward to the free uncut surface (AB in Fig. 10). The metal below this shear plane is assumed to be plastically unstrained while that in the chip above the shear plane is assumed to be in a constant state of plastic strain. While such a simple picture represents a useful first approximation, it is not always well approximated by actual chips.

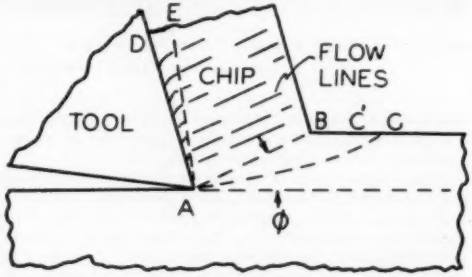

FIG. 10 DIAGRAMMATIC REPRESENTATION OF SHEAR FLOW CONDITIONS AT THE POINT OF A CUTTING TOOL

When motion pictures are taken of the magnified region in the vicinity of the tool point, two important deviations from the foregoing picture are frequently observed:

1 There is no single shear surface, but shear is observed to occur initially along curved line AC (Fig. 10) and continues throughout the entire area ABC bounded on the top by line AB (Fig. 10).

2 Some additional strain is evident in the chip above line AB. However, this additional strain is confined to a wedge-shaped region (ADE in Fig. 10) that is immediately adjacent to the tool face.

While Figs. 11 to 13 illustrate the existence of the shear zones ABC and AEC of Fig. 10, these important deviations from the idealized picture of chip formation are best revealed by motion pictures. In this technique the camera is focused upon the highly polished surface of the metal that is being cut by a two-dimensional tool. The Lüders lines that thus appear clearly indicate the direction of shear flow at each point in the specimen. These lines are not the same as the lines that are evident on a polished and etched photomicrograph of a chip, which are lines of maximum crystal elongation rather than flow lines. A film will be shown at the 1951 ASME Annual Meeting which clearly illustrates the existence of the two zones under a variety of cutting conditions. Such studies reveal that shear zones ABC and ADE become larger and more pronounced as cutting conditions are altered to produce a relatively thick chip. The two shear zones are observed to virtually disappear only when the cutting conditions approach the ideal (i.e. cutting a hard material using an effective fluid to insure low friction along the tool face). Conversely, these shear areas are

most pronounced when metals with a strong tendency to strain-harden are cut under conditions to produce a thick chip.

An explanation of the origin of the two shear zones that are evident in the motion pictures to be shown at the Annual Meeting may be given in terms of the tendency for a metal to strain-harden and the size effect.

The initial shear line (AC in Fig. 10) would appear to be a line of maximum shear stress. The mean shear stress along this surface may be approximated by dividing the cutting force component along the surface by the area of surface AC. If additional slip is to occur along a line such as AC′ a mean shear stress larger than that encountered along AC will be required due to the strain hardening the metal experiences when the initial strain occurs along line AC. But a higher stress is available along AC′ due to the fact that the area along AC′ will be less than that along AC. Slip may thus proceed progressively on a multiplicity of surfaces in the region ABC. Further slip will not occur beyond some line AB beyond which the shear area again begins to increase.

It is customary to compute the mean shear stress along line AB in consideration of metal-cutting data. This stress is usually thought of as the flow stress corresponding to the strain in the chip. A single stress-strain curve is assumed to exist for a given metal that is cut. However, a considerable evidence has been found in support of a size effect in which metals are assumed to exhibit a greater flow stress as the size of the specimen is reduced. In the present discussion the zone ABC represents the "specimen size," and the mean shear stress required in the formation of a chip from a given metal should be expected to increase as the area ABC decreases. The presence of shear zone ABC and the accompanying size effect has been used to explain adequately the anomalous result described in another paper in which the mean shear stress was observed to decrease as the shear strain in the chip increased ("The Rotary Tool," by M. C. Shaw, P. A. Smith, N. H. Cook. ASME paper No. 51—A-62). The further significance of shear zone ABC will be discussed in a later paper.

Shear zone AED may also be accounted for in terms of the tendency for metal to strain-harden and the existence of a size effect. All along the tool face only surface asperities make contact. The real area of contact between chip and tool is less than the apparent area of contact. The tool face is subjected to large shear stresses which result from the friction process. The shear stress along the tool face may frequently exceed the value of stress the metal has been subjected to in crossing line AB. When this happens, additional slip will occur in the chip metal just below the chip-tool interface. Such additional slip is evident in the tendency for the flow lines in the chip to bend downward. At first the additional shear strain lies close to the tool face (i.e , in the vicinity of tool point A) but as the chip passes up the tool face the thickness of the additional flow zone increases as the metal strain-hardens. A characteristic shear zone that is triangular in shape is frequently observed in motion pictures of the cutting process. The presence of such a shear zone plays a significant role in the cutting process, particularly in connection with such questions as the formation of the built-up edge, the discontinuous chip, and tool wear. Discussion of these matters will also be deferred to a later paper.

The purpose of this note is merely to focus attention upon the existence of two important deviations from the usually assumed picture of chip formation that are due to the size effect and the tendency for metals to strain-harden. A further object is to announce that motion pictures will be presented at the 1951 ASME Annual Meeting in Atlantic City, at the Production Engineering V—Metal Cutting II Session, which clearly demonstrate the existence of these significant deviations.

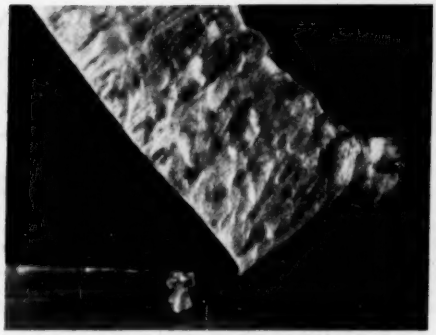

FIG. 11 PHOTOGRAPH OF 61S-T ALUMINUM BEING CUT UNDER GOOD CONDITIONS

(A small primary shear zone is evident along the shear surface and a negligible secondary flow zone along the chip-tool interface. Rake angle, 40 deg; depth of cut, 0.020 in.)

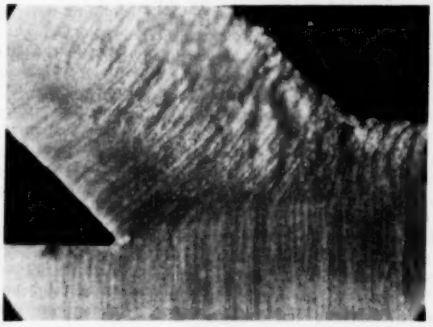

FIG. 12 PHOTOGRAPH OF 2S ALUMINUM BEING CUT

(Here a large primary flow zone is evident with a negligible secondary flow zone along the tool face. Rake angle, 40 deg; depth of cut, 0.020 in.)

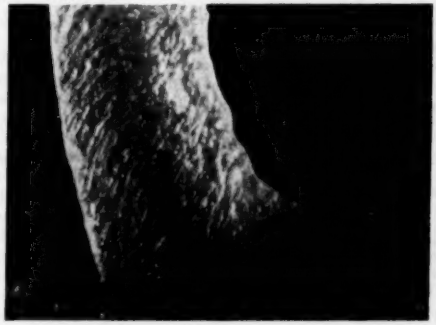

FIG. 13 PHOTOGRAPH OF BRASS SPECIMEN BEING CUT

(A small primary shear zone is evident with a large secondary shear zone along the tool face. Rake angle, 15 deg; depth of cut, 0.010 in.)

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Petroleum Mechanical Engineering

Differential Head Meters Useful to the Petroleum Industry, by Howard S. Bean, Fellow ASME, National Bureau of Standards, Washington, D. C. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-1** (mimeographed).

DIFFERENTIAL head meters for fluids are unique in that the metering elements, usually called the primary elements, are identical for both liquids and gases. Also, the secondary or recording elements may be the same, or nearly the same, except for possible differences in the scale range and details of connecting the primary and secondary elements. Finally, the factors (flow coefficients, etc.) to be used in computing the flow of either liquid or gas may be obtained from the same set of curves or tables for most, but not all conditions that may be of interest in the petroleum industry.

All differential head meters are not equally suited for the different service conditions. Some meters have distinct advantages for some service conditions and others just as distinct advantages for other conditions. This paper discusses, from the standpoint of the petroleum industry, some of these advantages and disadvantages, and mentions a few of the recent papers in which more detailed information may be found. Also, since the petroleum industry is concerned with gases as well as liquids, meters for both these fluid phases will be considered.

The types of differential-head meters included in the discussion are the three well-known forms: The Venturi tube, the flow nozzle, and the thin-plate square-edge orifice. Other types mentioned are the tapered tube and plug, the elbow, the Gentile flow tube, and friction flowmeters.

Notes on Positive-Displacement Meters for Liquid Hydrocarbons, by E. W. Jacobson, Mem. ASME, Gulf Research and Development Company, Pittsburgh, Pa. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-25** (mimeographed).

THE Joint ASME-API Committee on Volumeter Research has standardized positive-displacement-metering practice by the development of a Tentative Code of recommended practice which is under constant study and frequent revision to keep it abreast of current best practice. This paper discusses the basic standard of measurement, measuring accuracy, the fundamental concepts of positive-displacement-meter theory, and presents the more successful designs of meters.

There are at least eight general designs of positive-displacement meters which have made good measuring devices. The pack-sealed reciprocating meters such as the duplex reciprocating-piston meter, the four-piston meter, and the five-piston nutating yoke meter, were the first to be developed. The early film-sealed designs were the oscillating piston meter and the duplex cylindrical-piston meter. Need for large-volume and low-resistance meters accelerated the development of the film-sealed rotary meters exemplified by the rotary sliding-vane design, the rotary bucket-vane meter, and recently the helical-fluted and lobed-impeller rotary meter.

Each of these designs has done and can do a splendid measuring job. The duplex reciprocating-piston meter and the oscillating-piston meter were first developed for use in service-station gasoline-dispensing service. They both have good power to drive bulky registers and will maintain their accuracy for long periods without adjustment. The oscillating-piston meter has been giving satisfactory service in larger sizes for tank trucks and bulk plants. The four-piston meter has been very useful in tank-truck service; however, it has been displaced in this service by the rotary-type meters which have considerably less pressure drop and less bulk for the same capacity.

The five-piston nutating yoke meter as built by Bowser has been an accurate, rather high-pressure-drop meter which has given good service in bulk plants and other service where plenty of pressure head was available in the flowing stream. In slightly modified design by other manufacturers this type meter has been quite satisfactory as a service-station gasoline dispenser. The Brodie duplex cylindrical-piston meter has been used in a wide variety of applications from crude-oil measurement to tank trucks and pipe lines. It is a medium-pressure-drop meter and has a minimum

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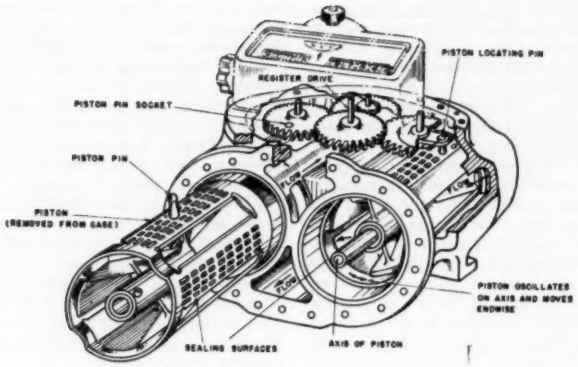


BRODIE DUPLEX CYLINDRICAL PISTON METER

of wearing parts. It has given way to the rotary-meter designs only because of capacity limitations.

The rotary meters have experienced rapid development and wide use. They have low pressure drop and are much smaller in bulk for the same capacity than are the piston meters. In general, their performance characteristics are not quite as good as the piston meters, particularly at low rates of flow below 15 per cent of full-rated flow. However, when properly selected for capacity and properly installed and operated, their measuring capabilities are exceedingly satisfactory. The fluted and lobed-impeller meter developed just recently by Brodie has shown good promise, particularly in the large sizes for ship loading, pipe-line service, and the like, on products ranging from Bunker C to gasoline.

Short Cuts in Pilot-Plant Engineering, by J. S. Rearick, Mem. ASME, The M. W. Kellogg Company, New York, N. Y. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-6** (mimeographed).

THE petroleum industry has had a leading role in the development of continuous process pilot plants, and these in turn have contributed in no small measure to advances in refining technology. The two major fields of pilot-plant utility are development of new processes and evaluation of the effect of changes on existing processes. In the former category pilot plants are used to bridge the gap between laboratory and plant, to determine the effect of operating variables, and to obtain engineering data necessary for the design of full-scale units. Where the process is already in commercial operation, the pilot plant makes it possible to study the effect of change in feed stocks and operating conditions or to predict the result of equipment modifications at reduced cost and without loss of production on the process unit. Where a new plant must be built for a known process, the pilot plant will furnish the design information necessary to adapt the process to the feed stock or other conditions peculiar to the specific job.

To be useful for any of these purposes it is essential that the results obtained from the operation of the pilot plant be representative of the performance of the full-scale unit. This particularly is true in the case of the engineering contractor who may be required to guarantee the performance of a commercial plant on the basis of such data. Consequently the pilot plant must be carefully engineered both from a process and from a mechanical standpoint. Since practically all of the elements of the large plant may be found in the pilot unit, engineering costs become excessive if carried out in the same detail as for a full-scale installation. It is the purpose of this paper to describe some engineering "short cuts" which have proved successful in holding such costs to a minimum.

It is pointed out, for example, that centralization of the responsibility for all phases of the design and the use of the same individual to follow and co-ordinate the fabrication and erection of the equipment, eliminate the necessity for much detail. Standard details and designs can be used repeatedly with consequent saving in engineering cost.

Latest Developments in Percussion Drilling, by Ross Bassinger, Bassinger Tool Company, San Antonio, Texas. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-26** (mimeographed).

IT HAS been pointed out that the hammer drills being used, due to the need for carrying a small amount of preloading on the bit, must use roller bits. This characteristic has both advantages and disadvantages, one advantage being that it is possible to drill with both a rotary action and percussive action. An inherent disadvantage is in the limited strength of a roller bit to take impact loading sufficient to drill formations which absorb percussive energy.

The bit companies have co-operated in this matter by designing bits specifically to transmit more of this force without being destroyed.

The combination of stronger bits and the newer technique of operation has shown some remarkable performance gains, notably in limestone and dolomites.

Most engineering opinion confirms the fact that a much greater percussive force is possible by the use of a solid or rigid type of bit such as is used in mining work, cable tools, etc. The use of a sintered-tungsten-carbide cutting edge on such bits has become common practice in the metal mines within the last two years.

Since it seemed desirable to use carbide inserted bits and since it was found that present hammer drills could not use them due to certain limitations, the Bassinger hop drill was designed specifically for this purpose.

The hammer drill is single-acting,

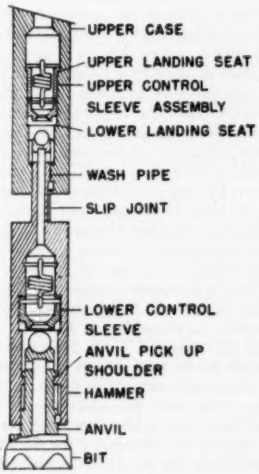


DIAGRAM OF HOP DRILL SHOWING PARTS IN THEIR OFF-BOTTOM POSITION, THAT IS, IN THE POSITION WHICH THE PARTS WOULD ASSUME WHEN THE DRILL IS HANGING IN THE HOLE

hydraulically actuated in the drilling stroke, and spring-returned. Enough energy is stored in the spring for the hammer return. This reduces the force of the drilling blow. However, this has not been detrimental inasmuch as heavier blows could not be used any way due to the existing bit strength. Maximum force per blow can be used on solid bits; therefore, included as a part of the hop drill design was double-acting operation, enabling the delivery of the drilling blow without compressing the springs.

Because the hop drill uses two power impulses per cycle versus the hammer drill's one, the severity of the shock wave reaching the surface has been greatly reduced.

Effect of Rock Properties on Drilling, by W. B. Mather, Southwest Research Institute, San Antonio, Texas. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-16** (mimeographed).

THE inconsistencies in our present employment of the term "rock hardness" are obvious. In the case of diamond, rotary, and percussion drilling, the usual definition of the term "hardness" is often belied by the drilling results obtained in the field.

In the case of diamond drilling where abrasion is believed to be the governing factor, there are other variables which cloud the picture. For example, there is the contention that finer-grained rocks are more difficult to penetrate than coarser-grained rocks of identical mineral composition, where the only apparent difference in these two rocks is that the finer-grained type contains more grain boundaries than the other, the inference being that grain boundaries exhibit a greater resistance to abrasion than the interior of the grain. In addition to rock texture, the degree of cementation, variation in mineral content, and existence of incipient fractures also have a marked effect on abrasive hardness.

The value of impact or indentation hardness and tests as a measuring device for ease of penetration by percussion tools is highly questionable. It appears that elasticity, tensile, and compressive strength are at least in part the governing factors in resistance to impact. The observation that percussion tools are often more successful in drilling shales than rotary and diamond drills does not depend upon the impact hardness of the shale, which is very high while its compression and abrasive hardness are low, but rather that the lubricating action of shale particles has little if any effect under impact while they are effective on rotating bits.

Other physical properties of rocks, at present considered unimportant, may be the bases of developing new drilling techniques and equipment in the future. For example, in the jet-piercing method of drilling, it is thermal expansion of the component minerals that is the important physical property.

The disparity between laboratory data and actual drilling results may be attributed partially to variations in the physical properties of minerals and rocks when buried under several thousand feet of overlying rock. If this is the case, the question then arises as to the character of the changes and the rate of variation of physical constants likely to be encountered at various depths below the earth's surface.

Employment of the term "penetrability" rather than hardness in discussing rock penetration would tend to decrease the existing confusion. In this way a rock of specific mineral composition would be penetrated at a definite rate under a specific type of drilling procedure. The term would be all-inclusive, applicable to jet piercing as well as any other future method of rock penetration.

Slush-Pump History and Possible Developments, by Roy E. Edwards, Gardner-Denver Company, Quincy, Ill. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-19** (mimeographed).

THIS paper traces the role of the slush pump in the development of the oil-well-drilling industry and indicates future lines of development for this type of pump.

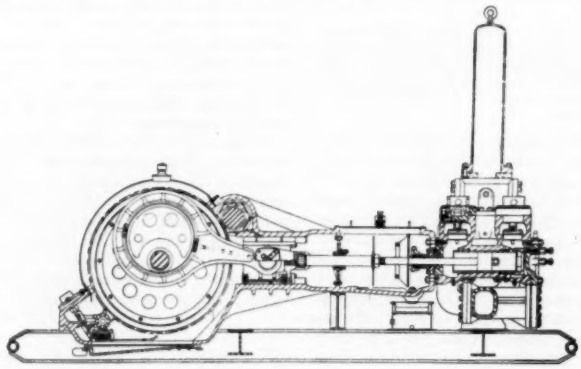
It is pointed out that (1) The steam slush pump is limited by the steam-generating plant; (2) lighter pumps for the same horsepower are in demand; (3) improved mud pumps are necessary to meet the demands of deeper drilling. Since drilling rigs are predominantly powered by internal-combustion engines and consequently require power pumps, it is along this line that manufacturers are continually striving to improve; (4) it appears that for deep drilling, with power pumps, hydraulic drives and series-parallel operation probably will be used more extensively; (5) the use of the converter drive may require a new method of rating power pumps; (6) a plunger pump having extreme flexibility is available to the industry for possible application to drilling operations.

Corrosion Resistance of Alloys in Amine Gas-Treating Systems, by F. C. Riesenfeld and C. L. Blohm, The Fluor Corporation Ltd., Los Angeles, Calif. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-12** (mimeographed).

ON the basis of the results obtained from corrosion-resistance studies in amine gas-treating plants over the past three years, the following was found:

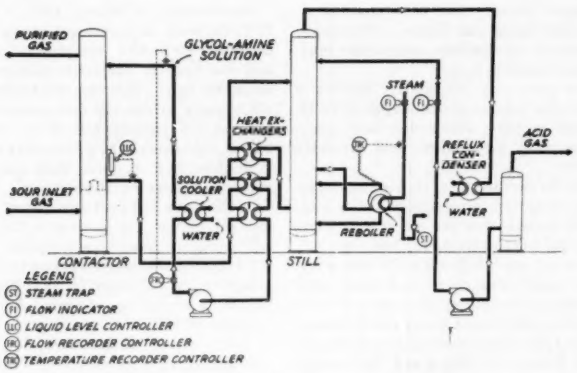
Glycol-Amine Systems. Heat-exchanger corrosion, which constitutes the major corrosion problem in glycol-amine plants, can be controlled satisfactorily by use of aluminum 3S or 4-6 Cr-$^1/_2$ Mo steel in the manufacture of exchanger bundles.

The data available at present indicate that carbon-steel reboiler bundles can be used economically provided that the proper operating conditions are maintained in the plant. A life of $3^1/_2$ to 4 yr



CROSS SECTION OF MODERN POWER PUMP

(Improvements include interchangeable right and left fluid cylinders, combination splash and force-feed lubrication, screwed-type valve covers and cylinder heads, one-piece connecting rods, double baffles to keep the mud out of the power end, lubricated piston-rod stuffing boxes, and hammer-up nuts for piston and extension rods.)



TYPICAL FLOW SHEET OF AMINE GAS TREATING PROCESS

can be expected from such bundles under such conditions.

Although most carbon-steel stills have given satisfactory service up to this time, the incidence of some failures in parts of these columns indicates that carbon steel is not an entirely satisfactory material for such service. Other materials have been and are still being investigated, and at present it is felt that a satisfactory remedy for still corrosion can be provided by the use of aluminum or stainless-steel lining in the region of the still defined by the feed tray and the fourth tray below the feed, or by constructing the entire upper portion of the still of such alloys. At present, aluminum is to be preferred for economic reasons as well as its indication of satisfactory corrosion resistance. In addition, preliminary small-scale experiments have indicated the possibility of utilizing aluminum metallizing for repair and protection of this region of still columns.

Aqueous-Amine Systems. In most aqueous-amine installations, carbon steel is a satisfactory material for the manufacture of heat-exchanger tubes. However, in certain plants where particularly corrosive conditions prevail, carbon steel and 304 stainless steel did not give satisfactory performance. Although little experimental evidence is at hand, it is felt that Monel, Carpenter 20, and possibly 316 stainless steel should perform satisfactorily in such cases.

Reboiler corrosion, which in most aqueous-amine plants constitutes the major corrosion problem, can be controlled satisfactorily by use of Monel, Carpenter 20, and type 316 stainless steel for the fabrication of reboiler bundles. Monel has so far shown the best results. In any case, however, the use of high-temperature heat, medium oil, and direct firing, which involves excessively high metal skin temperatures, are definitely contraindicated.

Experience indicates that in most instances carbon steel has performed reasonably satisfactorily in aqueous-amine stills. At present, no information is available on the use of alloys in such installations except type 304 stainless steel, which has given adequate service in a few stills operated for considerable periods of time.

Analysis of Some Corrosion Problems in Petroleum Refineries, by John F. Mason, Jr., International Nickel Company, New York, N. Y. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-4** (mimeographed; to be published in Trans. ASME).

OVER the past 25 years the Corrosion Engineering Section of the Development and Research Department of the International Nickel Company has co-operated with the petroleum industry in analyzing corrosion problems encountered in refineries and in running spool tests to determine the most suitable and economical materials that might be used in specific applications. This paper presents 15 actual corrosion problems that have been submitted for consideration and shows the steps taken to analyze them in the light of practical experience and available test data obtained under the same or similar conditions. In some cases, where the problems were not readily solvable based on available information, it was necessary to resort to the installation of spool-type specimen holders in the operating equipment to determine the relative suitability of various metals and alloys under actual service conditions.

Generally, the problem concerns the initial use of carbon steel for the various equipment items and their premature failure for one reason or another. Among the services involved are gas oil, depropanized naphtha crude oil, spent sulphuric acid alkylate, naphthenic-base crudes, caustic soda and sodium plumbite, furfural, reduced crude vapors, and cracked propane distillate. The refinery units consisted of heat exchangers, regenerator towers, crude flash towers, accumulators, cracking coils, light fuel-oil treaters, process furnace tubes, and debutanizer tower tops. The quantitative test data presented were all obtained through the use of spool-type specimen holders.

From the nature of the problems it is indicated that type 502 stainless steel is a highly acceptable and reasonably economical material as a replacement for mild steel except in instances where mineral acids or chlorides may be present as well as highly alkaline solutions at elevated temperatures. Under the latter conditions the trend is toward the use of more highly alloyed materials such as Monel and nickel together with the copper-base alloys like 70-30 cupronickel, Admiralty metal, and Muntz metal.

Offshore Structures—Some Considerations in Their Design Fabrication and Construction, by M. B. Willey, J. Ray McDermott & Company, Inc., Harvey, La. 1951 ASME Petroleum Mechanical Engineering Conference paper No. **51—PET-15** (mimeographed).

SHOULD the Gulf of Mexico once more become active as a drilling area, the oil companies will again be faced with the problem of the selection of satisfactory offshore structures. This paper presents a restatement of the varied and complex nature of the problem. It attempts, from a study of installations made and used during the past four years, to point the way to better future designs.

In order to approach close to a realization of the ideal platform, it is necessary to have complete knowledge of the conditions which the structure will be required to meet. This knowledge includes the following:

1 Proper drilling equipment should be selected and arranged to secure maximum workability in minimum deck space.

2 Thorough investigation of the Gulf floor to a depth at least 30 ft below the maximum pile penetration should be carried out by means of borings and actual pile tests at the proposed location.

3 An understanding of the forces of nature which the platform must satisfactorily resist is essential.

4 Another consideration of prime importance is the possibility of securing

commercial production from the well or wells to be drilled from the platform.

5 Two general types of drilling platforms have been used: (*a*) a large self-contained structure, and (*b*) a much smaller one in conjunction with a separate floating unit.

History of Magnetic Exploration, by Walter Ruska, Ruska Instrument Corporation, Houston, Tex. 1951 ASME Petroleum Mechanical Engineering Conference paper No. 51—PET-18 (mimeographed).

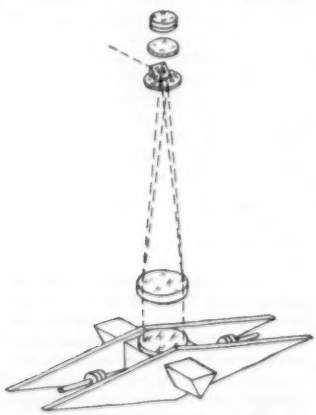
THIS paper, besides giving the early history of the compass and its earliest use for magnetic prospecting, describes successive developments in magnetic prospecting instruments up to the modern field magnetometers.

The earliest report of systematic magnetic prospecting comes from Sweden in 1640, where Swedish mining engineers discovered a new and original use of the Nuremberg sundial compass which at that time was already 200 years old.

Another early magnetic instrument that was found to be useful for magnetic prospecting was the inclinometer or dip needle that was originally designed by Robert Norman in 1576.

One application of the dip needle was introduced in the middle of the seventeenth century when Daniel Tilas developed the Swedish mining compass.

In 1634 Gellibrand in London discovered that the declination of the magnetic needle varied with time. In 1701 Edmond Halley, the English astronomer, published the first declination map of the Atlantic Ocean. In 1722 Graham observed diurnal changes of the earth's magnetic field in England. The existence of magnetic storms and their relation to sunspot activity had been established. In 1832 Gauss and Weber, in Germany, measured the absolute value of the horizontal intensity.



PRINCIPLE OF SCHMIDT'S VERTICAL MAGNETOMETER

Of particular importance became a magnetic balance system designed by H. Lloyd in 1874, which was later incorporated in the modern field magnetometer.

In the first decade of the twentieth century magnetic prospecting had become well known, but its use was still restricted to prospecting for iron ores.

In the years following the first world war rapid advances in instrument technology and exploration techniques were made in the United States and Germany.

In 1924, W. O. Hotchkiss of the Michigan College of Mining and Technology, developed his superdip magnetometer.

Ten years before Hotchkiss, Prof. Adolph Schmidt of the Potsdam Magnetic Observatory in Germany, designed a magnetometer that became known in this country in 1923. The Schmidt magnetometer has established itself as the standard instrument for precise magnetic surveys.

A new magnetic surveying instrument, the air-borne magnetometer, has been introduced during the past ten years. This magnetometer is based on the "Fluxgate" principle and is not a mechanical-optical device, but rather an electronic instrument. The basic development of this instrument was the work of the Gulf Research and Development Corporation in Pittsburgh.

High-Compression Spark-Ignition Gas Engines, by George Steven, Worthington Pump and Machinery Corporation, Buffalo, N. Y. 1951 ASME Petroleum Mechanical Engineering Conference paper No. 51—PET-23 (mimeographed).

FULL-LOAD fuel consumptions on a supercharged engine rated 120 bmep and using 12:1 compression ratio, have been realized on the order of 6400 Btu per bhphr.

This value is, of course, a research test value, but for conservative everyday operation, a fuel consumption of 6800 Btu per bhphr is quite reasonable and comfortable.

It is believed, however, that an engine which will never have to operate on any fuel other than gas and where spark ignition, is desired, there is some considerable merit to adjusting the compression ratio to a somewhat lower value.

A value of 10:1 in place of 12:1 will provide an engine with less susceptibility to detonation. It will therefore be able to carry higher loads without intercooling and the fuel consumption, while not as good, will not suffer too badly.

For example, in March, 1949, a 9 × $10^1/_2$ naturally aspirated gas engine was designed with 10:1 compression ratio and has been in operation successfully since that date. This unit was similar in all respects to the low-compression engine of 5.5 compression ratio, except that a turbulence-type piston was used. A high-tension magneto with aircraft-type spark plugs was incorporated. This unit showed a full-load economy of 7500 Btu per bhphr. A number of $12^1/_4$ × $14^1/_2$ engines have been supplied with 10:1 compression ratio showing fuel consumption on the order of 7500 Btu per bhp-hr with ratings increased from 75 bmep to 80 bmep.

Tests on a 16 × 20 four-cycle supercharged engine were conducted with 8.23 compression ratio. Load tests were carried to as high as 145 bmep without detonation and without the use of an intercooler. The ambient temperatures during this test were 80 F to 90 F. Fuel consumption of this unit was 6700 Btu per bhp-hr at 120 bmep.

This compares with the previously mentioned fuel consumption of 6400 Btu per bhp-hr with 12:1 compression ratio, but with the use of intercooling to obtain 120 bmep. It was found that as the compression ratio goes up, the economy improvement becomes less effective.

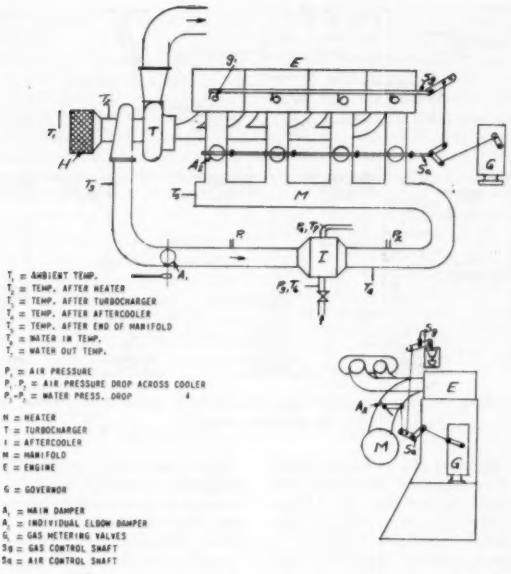
As a result of the higher compression temperatures which develop, the engine becomes more susceptible to detonation and is, therefore, somewhat more critical for the average operator to handle, unless it is suitably intercooled.

The cost of circulating cooling water might be considered against the fuel cost; and in certain localities, it might prove to be more economical to burn a somewhat greater quantity of fuel than to pay for the cost of additional water or the pumping of same together with the additional maintenance which a properly maintained cooler requires.

During the early part of 1948 an $8^1/_2$ × 13 two-cycle exhaust valve-in-head Diesel engine was converted to operation as a spark-ignition gas engine. The compression ratio was actually 14:1. The unit also operated successfully, although the load was limited due to the magnitude of the compression ratio.

New spacer pieces were installed and compression ratio was reduced to a value of 8:1 under which conditions it was possible to carry 110 bmep without detonation.

On the basis of this research, a larger engine of 16-in. bore and 16-in. stroke operating at 320 rpm was developed. The design of this engine incorporated exhaust valves-in-head and intake ports in the cylinder liner, scavenging air being


T_1 = AMBIENT TEMP.
T_2 = TEMP. AFTER HEATER
T_3 = TEMP. AFTER TURBOCHARGER
T_4 = TEMP. AFTER AFTERCOOLER
T_5 = TEMP. AFTER END OF MANIFOLD
T_6 = WATER IN TEMP.
T_7 = WATER OUT TEMP.
P_1 = AIR PRESSURE
P_2-P_3 = AIR PRESSURE DROP ACROSS COOLER
P_4-P_5 = WATER PRESS. DROP
H = HEATER
T = TURBOCHARGER
I = AFTERCOOLER
M = MANIFOLD
E = ENGINE
G = GOVERNOR
A_1 = MAIN DAMPER
A_2 = INDIVIDUAL ELBOW DAMPER
S_g = GAS METERING VALVES
S_g = GAS CONTROL SHAFT
S_a = AIR CONTROL SHAFT

INSTALLATION AND INSTRUMENTATION OF A 12:1 COMPRESSION RATIO SUPERCHARGED GAS ENGINE

supplied by a reciprocating compressor.

The compression ratio was established at $8^1/_4$ to 1, resulting in a compression pressure of 265 psi.

The rating was established at 77 bmep but overloads have been carried for long operating periods on test to as high as 110 bmep.

Considerable gains of performance from the standpoint of load capacity and fuel consumption have also been obtained by higher compression in the conventional loop-scavenged two-cycle design and some low-compression units have been changed over in the field with beneficial results.

Management

Industrial Growth and Corporate Taxation, by J. F. Manildi, Mem. ASME, University of California, Los Angeles, Calif. 1951 ASME Fall Meeting paper No. 51—F-22 (mimeographed).

THE increase in government spending necessitated by defense requirements brings the question of corporate taxation into sharp focus. Meeting defense requirements necessitates that our production capacity works smoothly and efficiently. An undue tax burden on industry, or an inequitable distribution of taxes within the industry will both be highly detrimental to our industrial output.

The influence of corporate taxation on industrial growth is examined quantitatively. The influence on growth of normal and excess-profit taxes is developed. The interrelation of growth, dividend payments, and taxes are examined with the object of evaluating the influence on investor incentive, which incentive will inevitably be reflected in our industrial growth. A quantitative analysis of the comparative effect of excess-profits taxes on large, established companies, as compared with newly established, young companies, is made. The results indicate the startling advantage presented to large established companies in this respect. Recommendations are made for a more equitable taxation structure within the industry in order to achieve maximum growth.

Management Is Imitated for Safety, by C. A. N. Armstrong, Mem. ASME, The Ocean Accident & Guarantee Corporation, Ltd., Omaha, Neb. 1951 ASME Fall Meeting paper No. 51—F-21 (mimeographed).

MANAGEMENTS of smaller firms have been reluctant to be impressed by the need for adequate safety measures. The common approaches of economy, efficiency, and ethics all apply to larger businesses, they think.

If accidents are charted like financial statements to show what you have and where it came from, and are beamed at the sensitivity of the business, management, whether of large or small firms, will quickly be interested. Once their interest is precipitated and proper actions developed, then an entirely new attitude takes place within the personnel structure of the firm.

This change in attitude is due to a very common human trait, and one entirely overlooked by those interested in propagating the science of accident prevention—namely, unconscious imitation.

Steam Power

Industrial-Plant Boiler-Feedwater Treatment, by D. C. Carmichael, Mem. ASME, E. I. du Pont de Nemours and Company, Inc., Wilmington, Del. 1951 ASME Fall Meeting paper No. 51—F-27 (mimeographed).

IN general, the preparation of water for boiler-feed purposes is accomplished by utilization of equipment for performing the services of (1) Sedimentation, (2) filtration, (3) softening, and (4) deaeration.

These processes may be used either singly or in combination depending upon the condition of the raw water. A properly conditioned feedwater should give the following results irrespective of the method used:

1 Heating and evaporating services of the boiler should be kept clean by reducing calcium, magnesium, and silica content of the water to low limits, and adherence of precipitated solids or sludge avoided by maintenance of a suitable condition in the boiler.

2 The metal of the boiler must be protected against corrosion by maintaining a satisfactory hydrogen-ion concentration or pH value and by eliminating free oxygen from the water.

3 Carry-over of liquids or solids in steam leaving the boiler must be reduced to a minimum.

If the source of raw water is a surface supply and it is necessary to use this supply for boiler feed, process, and domestic, sedimentation and filtration is required for clarification. Under such conditions it is usually the most economical design to use some form of Zeolite softening for the boiler-feedwater treatment. Four to six hours sedimentation is required by most State Boards of Health for drinking water.

Evaluation of the Effect of Terminal Difference and Pressure Drop on Steam-Power-Plant Heat Rate, by W. F. Allen, Jr., Jun. ASME, Stone and Webster Engineering Corporation, Boston, Mass. 1951 ASME Fall Meeting paper No. 51—F-28 (mimeographed).

A SIMPLE precise method of differences is presented which enables the effect of minor variations in turbine extraction-feed-heating arrangements for a fixed turbine design to be computed much more rapidly than by calculating complete heat balances for all conditions. These minor variations, which have a significant effect upon the construction and operating costs of present-day high-temperature high-pressure steam-power stations include terminal difference, extraction steam-line pressure losses, and cascading versus pumping heater drips.

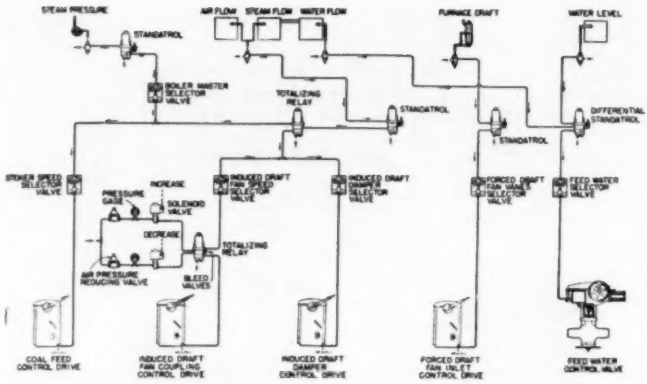
In order to illustrate the procedure and the degree of accuracy obtainable with the method, heat-rate changes due to terminal difference and extraction-line pressure drop are presented for a 60,000-kw preferred standard turbine-generator unit, 850 psig, 900 F with five heaters. These results are compared with those obtained by two short-cut methods proposed in the literature. The comparison shows that although adequate for indicating the total effect due to the existence of terminal difference at all heaters and the total effect due to the existence of pressure drop in all extraction lines, the short-cut methods are unsatisfactory for application to individual heaters and extraction lines in order to determine the most economical amount of heater surface and pipe size.

Fuels—Power

Operation of Large Power Boilers With Lignite Coals From the Dominion of Canada and Northern United States, by J. W. Hoffman, Northern States Power Company, Minneapolis, Minn., and John M. Drabelle, Fellow ASME, Iowa Electric Light and Power Company, Cedar Rapids, Iowa. 1951 ASME Fall Meeting paper No. 51—F-18 (mimeographed).

THE use of lignite coals in large power boilers in central electric generating stations and large industrial applications in the Dominion of Canada and northern United States is discussed. It is a historical recitation of the development and experience of users, with a tabulation of design data and presentation of the present thinking in such firing.

To obtain a cross section of current design practice for boilers of 50,000 lb per hr and larger, questionnaires were sent to the larger utility and industrial users of lignite in the states of North Dakota, Wyoming, and Minnesota, and in the Canadian provinces of Alberta and Saskatchewan. The replies from five United States companies reported 14 boiler installations of which 13 were stoker-fired (all with continuous-discharge grates) and one pulverized-fuel-fired. The three Canadian companies reported on a total of three boiler installations, one stoker-fired with continuous-discharge grate, and two pulverized fuel. This group represents a total of five boiler manufacturers and four stoker manufacturers and all installations were put in service within the past five years.



BAILEY COMBUSTION AND FEEDWATER-CONTROL SYSTEM, OTTER TAIL POWER COMPANY, ORTONVILLE, MINN.

The data reflected the relatively conservative furnace design now being used. For example, installation designed for higher-quality Midwestern fuels normally are designed for heat releases more in the range of 650,000 to 700,000 Btu per sq ft of active grate area per hr and 25,000 to 30,000 Btu per cu ft of furnace volume per hr. The questionnaire disclosed that there is quite a variation in the Btu per sq ft of projected waterwall surface on lignite-burning installations. This is primarily due to the rapid increase in the amount of waterwall surface in lignite furnaces in recent years. Many of the earlier installations had water walls only on the rear wall or on the rear and side walls, and the spacing ranged from 10 to 12 in. More recent stoker-fired installations have waterwalls on all four sides of the furnace and the spacing has been reduced to a range of 6 to 7-in. centers or less. All installations reporting are using preheated air. Although the average temperature is slightly over 350 F, the latest installations are above this value which indicates the trend is toward 400 F.

Fully automatic combustion-control equipment contributes much to the success and dollar economy of firing lignite coal. Typical of such installations is the Bailey combustion and feedwater control system for the Otter Tail Power Company at their station at Ortonville, Minn. When burning lignite coal, overfire air is not essential from the standpoint of smoke, but it is desirable from the standpoint of turbulence in the furnace. The usual method of control of overfire air is from a linkage connected to the stoker control drive or a linkage connected to the forced-draft damper control drive. A third method of operation is to provide a separate control drive operated from the master pressure controller.

Basic Elements of Design and Operation of Steam-Generating Units for Utilization of North Dakota Lignites, by L. Pistner, Fuel Economy Engineering Company, St. Paul, Minn. 1951 ASME Fall Meeting paper No. 51—F-20 (mimeographed).

THIS paper places emphasis upon direct utilization of lignite fuels without prepreparation, separate moisture reductions, or other methods of beneficiation. High and low-temperature distillation, carbonization, and gasification are the subjects of separate discussion.

Three different methods of burning lignite as fuel are in common and general use. They are summarized as follows, including a statement of the principal composition of the steam-generating unit from the standpoint of the type of heat-recovery equipment which is being used:

1 Forced-draft-zoned traveling-grate stokers. (*a*) With economizer and air

preheater in series; (*b*) with air preheaters only.

2 Spreader stokers. (*a*) With economizer and air heater in series; (*b*) with air heater only.

3 Unit-type pulverized-coal firing. Utilizing primary and secondary-air preheaters, with high primary-air temperatures admitted to mills and secondary lower preheated-air temperatures admitted to burner plenum boxes.

This paper includes illustrations showing the general arrangement of units designed in accordance with the three methods of fuel firing listed. These figures include details as to composition of heating surfaces, general arrangement details, and over-all performance secured.

Heat Transfer

Line-Reversal Techniques in the Determination of Temperature of Gunflash or Other Rapid Transient Phenomena, by J. T. Agnew, Mem. ASME, Purdue University, Lafayette, Ind. 1951 ASME Fall Meeting paper No. 51—F-6 (in type; to be published in Trans. ASME).

A MODIFICATION of the conventional line-reversal technique has been utilized for the determination of the temperature of an exploding gas mixture. A monochromator, employing either a photomultiplier or lead-sulphide photoconductive cell as the detector, has been used to isolate characteristic sodium, potassium, and water-vapor radiation at 0.589, 0.77, and 0.942 microns, respectively. Peak temperature values were determined for the external gaseous explosion commonly known as secondary flash, associated with the firing of a gun. Values obtained by reversal of the characteristic radiation just mentioned did not agree even when corrected for the possible error due to the variation in emissivity of the tungsten comparison source. This result was not unexpected and is discussed in terms of the reaction kinetics involved. A general discussion of the significance of temperature of gaseous explosions is also presented. It is believed that techniques such as those presented should be useful in combustion research.

Distribution of Heat-Transfer Coefficients Around Circular Cylinders in Crossflow at Reynolds Numbers From 20 to 500, by E. R. G. Eckert, Mem. ASME, National Advisory Committee for Aeronautics, Lewis Flight Propulsion Laboratory, Cleveland, Ohio, and E. Soehngen, U. S. Air Force, Office of Air Research, Dayton, Ohio. 1951 ASME Fall Meeting paper No. 51—F-9 (in type; to be published in Trans. ASME).

AN experimental investigation using the Zehnder Mach interferometer reveals the temperature field around heated cylinders in air stream normal to the axis. From the temperature distribution the local distribution of the heat-transfer coefficient around the cylinder circumference is obtained. The thermal boundary layers are quite thick, especially for the lower Reynolds numbers investigated and the separation occurs farther downstream than at high Reynolds numbers. Accordingly, the contribution of the stagnant region at the downstream side of the cylinder to the over-all heat transfer is low (approximately 15 per cent), and the heat flow into the upstream side is much larger than into the downstream side.

Process Industries

Measurement of Particle-Size Distribution of Flour, by Kenneth T. Whitby, Jun. ASME, University of Minnesota, Minneapolis, Minn. 1951 ASME Fall Meeting paper No. 51—F-26 (mimeographed).

THE problem of determining the particle-size distribution of various materials has been thoroughly covered in many aspects by previous investigators. Therefore, as it exists today, the problem is chiefly one of adapting existing methods to the measurement of a particular substance over a specified range by developing apparatus and modifying the technique to give the desired accuracy at a minimum investment of equipment and time. With the foregoing in mind the Milling Engineering Division of the Department of Mechanical Engineering of the University of Minnesota, set out during the summer of 1948, to develop methods for measurement in the subsieve range as a preliminary step in the study of mill dusts.

The light beam balance based on the Oden direct-weighing sedimentation method was found to be a satisfactory and relatively simple instrument for the determination of particle-size distribution of flour and similar particulate materials over the range from 300 to 3 microns in size.

A sample size of approximately 8 grams is relatively small, yet large enough to eliminate many of the difficulties in obtaining a representative sample.

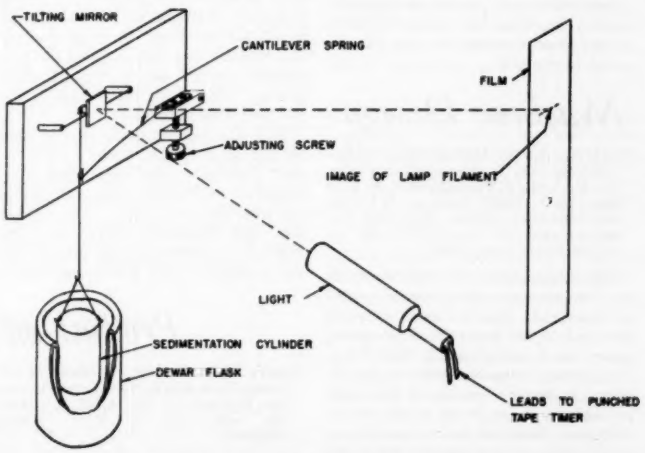
The time required to obtain time weight data on an ordinary flour ranging in size from 2 to 200 microns is approximately 1½ hr when using kerosene as the suspending medium. Time required for computation of results is approximately 10 min by the short method and 40 min by the method of tangents.

Benzene, kerosene, and kerosene-oil mixtures are satisfactory suspending fluids.

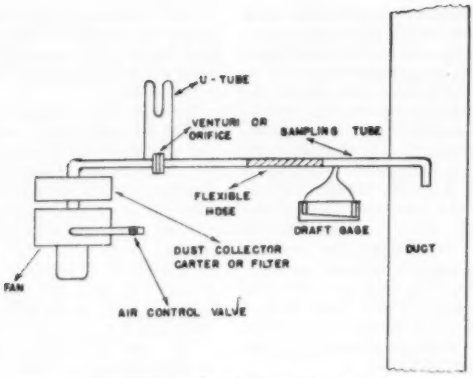
A comparison between data obtained by sedimentation and the conventional microscopic method shows that there are differences caused by variations in particle shape, and density with size.

The Determination of Dust Concentration in Flour-Mill Suction Systems, by John M. MacKenzie, University of Minnesota, Minneapolis, Minn. 1951 ASME Fall Meeting paper No. 51—F-29 (mimeographed).

EQUIPMENT, methods, and results are described for the determination of



SCHEMATIC DIAGRAM OF LIGHT BEAM BALANCE



ARRANGEMENT OF SAMPLING EQUIPMENT

dust concentrations in the air flowing in the ducts of flour-mill suction systems. Samples taken from the cyclone discharge are used to compute the collection efficiency by weight.

In its present stage of development this technique can determine dust concentration and collect a sample for particle-size measurement under actual operating conditions in the mill.

The results of tests made with this method indicate that some cyclone collectors can perform with relatively high efficiencies in terms of per cent of dust recovered. The very low concentrations of dust required for the return of clean air to the mill indicates the need for careful consideration of dust loading per cubic foot of air supplied to the collector as well as the dust concentration in the clean air.

Further study is needed to establish working limits for the permissible level of dust concentrations in clear air returned to the mill.

Machine Design

Characteristics of Dished-Plate (Belleville) Springs as Measured in Portable Recording Tensiometers, by J. J. Ryan, Mem. ASME, University of Minnesota, Minneapolis, Minn. 1951 ASME Fall Meeting paper No. 51—F-2 (in type; to be published in Trans. ASME).

THE development of portable recording tensiometers (force versus time) for maximum tension loads between 5000 and 16,000 lb presented an opportunity for determining the load-deflection characteristics of a series of dished-plate (Belleville) springs of the same size and shape, except for a variation in thickness. Without such an instrument, capable of microscopic measurement, the deflections of these initially coned, annular-disk springs of uniform cross section are exceedingly difficult to obtain. This paper describes the tensiometer and compares the theoretical methods of calculation of the spring deflections with the results of the load-deflection tests. Dished-plate (Belleville) springs of the kind discussed here are capable of carrying heavy loads in a small space with near-linear deflections, and an analysis of the design characteristics may encourage their application in other machine elements.

The Machine-Tool Laboratory at the University of Illinois, by Lawrence E. Doyle, Mem. ASME, and William C. Deem, Jr., University of Illinois, Urbana, Ill. 1951 ASME Fall Meeting paper No. 51—F-10 (mimeographed).

DURING the past year the Department of Mechanical Engineering of the University of Illinois moved into its new $1,600,000 building. A large part of this building has been allotted for production courses in mechanical engineering. One of the major units is the Machine Tool Laboratory.

Two main courses in metal processing are offered at the University of Illinois. One is an elementary course and is required for most engineering students and for some in other fields, like applied arts and industrial education. The other is an advanced course, intended for the students in the production option but open to those in other options of mechanical engineering. Each course gives three semester hours of credit and calls for two class hours and a three-hour laboratory period a week. The aim of these courses is to teach the basic practices of metal processing and the principles underlying them; to give an appreciation of the problem involved and the solutions to them as part of the background of engineering. That is the key to the whole scheme—to present metal processing from the engineer's viewpoint rather than from the mechanic's.

The main laboratory contains about 140 machine tools. Among the basic types are 31 lathes, 14 milling machines, 15 drill presses, and 10 cylindrical grinders. Representative of production machines are gear shapers, hobbers, and shavers, turret lathes, automatic screw machines, production boring machines, a centerless grinder, and a horizontal broaching machine. The machines are grouped according to types in sections separated by wide aisles giving ready access to the working areas. Power is carried through overhead ducts and brought down by conduits to junctions convenient to serve groups of several machines.

The Theory and Design of Long-Deflection Constant-Force Spring Elements, by F. A. Votta, Jr., Jun. ASME, Hunter Spring Company, Lansdale, Pa. 1951 ASME Fall Meeting paper No. 51—F-11 (in type; to be published in Trans. ASME).

A THOROUGH study of the "neglator," its present and predictable applications and design procedures, are discussed in the light of two years' experience in neg'ator development, research, and testing. The neglator is characterized by properties which permit it to exert constant or controlled varying force through theoretically infinite deflection. Design formulas and operation of the three major forms of the neg'ator, (1) extension member, (2) A-motor, and (3) B-motor, are discussed and illustrated. The major existing applications of the neglator are examined in terms of form, function, field, and type of mechanism and are illustrated by several representative designs.

Production Engineering

Angles for Machining, by Prof. M. F. Spotts, Mem. ASME, Northwestern University, Evanston, Ill. 1951 ASME Fall Meeting paper No. 51—F-19 (mimeographed).

FOR a machining operation, trial and error is ordinarily used to orient an inclined plane of a workpiece into the proper position on a machine tool. This process is wasteful of time and often results in spoiled work. This article attempts to correct the situation by de-

scribing in detail some simple mathematical methods for calculating the angles required to rotate the inclined plane into the horizontal. Numerical examples accompany all the mathematical developments.

Metals Engineering

An Experimental Investigation of Over-Straining in Mild-Steel Thick-Walled Cylinders by Internal Fluid Pressure, by M. C. Steele and John Young, University of Illinois, Urbana, Ill. 1951 ASME Fall Meeting paper No. 51—F-3 (in type; to be published in Trans. ASME).

THE purpose of this paper is to study the mechanism of yielding and to compare with plastic theories strains observed at the bore and outside surfaces of mild-steel cylinders of 2:1 diameter ratio under internal fluid pressure. Observations disagree with theoretical assumptions concerning the progression of yielding; wedge regions of overstrained material, occupying a small fraction of the total volume, characterize the yielding process. Discrepancies with theory are observed in the measured strains. The fully plastic load-carrying capacities predicted from theory are higher than those observed in the experiments. Stability of deformation (creep) under maintained constant loads is discussed.

Peculiar Behavior of Steel Beams Under Dead Loads That Produce Inelastic Strains, by H. T. Corten, M. E. Clark, and O. M. Sidebottom, Jun. ASME, University of Illinois, Urbana, Ill. 1951 ASME Fall Meeting paper No. 51—F-4 (in type; to be published in Trans. ASME).

INELASTIC deformation in metals is known to be a time-dependent phenomenon; however, the theoretical relations between load and deformation do not, in general, include the effect of time. Most of the experimental data, confirming these theoretical relations, have been obtained using screw-powered or hydraulic testing machines in which the load "falls off" as inelastic deformation occurs. Furthermore, these tests have been made without regard to the length of time necessary for inelastic deformation to cease at any given load. This investigation was undertaken to determine the effect of testing members under dead load where each increment of load could be maintained on the member a sufficient length of time until equilibrium was attained. Five statically determinate beams, four mild-steel beams of various cross sections, and one rail-steel rectangular beam were tested in a dead-load testing machine. The load-deformation diagrams were found to have a stair-step appearance, unlike the smooth continuous curves usually reported. The ultimate load-carrying capacity of the mild-steel beams was found to be considerably below that predicted by theory, and time delays of appreciable magnitude were observed for the initiation of inelastic deformation at a given load. A more stable behavior was observed for the rail-steel beam under dead load, and the experimental results were found to correlate well with theory.

Dynamic Properties of Nodular Cast Iron—Part I, by Harry Majors, Jr., Mem. ASME, University of Alabama, University, Ala. 1951 ASME Fall Meeting paper No. 51—F-5 (in type; to be published in Trans. ASME).

THIS paper presents the experimental results of an investigation on the mechanical properties of magnesium-treated nodular cast iron in the annealed and as-cast condition. The dynamic stress-concentration factors are compared with Neuber's theoretical factors for hyperbolic notches, with Peterson's results on steel, with Frocht's photoelastic results, and with Grant's data on flake cast iron and cerium-treated nodular iron. Fatigue results are shown for square and 45-deg V-shaped notches at speeds of 200 and 6000 rpm, as well as for various notch depths. The trend in size effect is indicated. Static damping capacities obtained from hysteresis loops in tension and compression are compared with torsional damping capacities and static damping capacities from bending.

Gas Turbine Power

A Contribution to the Problem of Designing Radial Turbomachines, by O. E. Balje, Fairchild Corporation, Farmingdale, L. I., N. Y. 1951 ASME Fall Meeting paper No. 51—F-12 (in type; to be published in Trans. ASME).

A METHOD is outlined for computing the characteristic values, such as pressure coefficient and efficiency of centrifugal compressors and radial inward flow turbines, as function of Reynolds number and Mach number, whereby the latter values are defined in such a manner as to represent the weight flow and the pressure ratio of the turbomachine. The influence of blade number, blade angle, speed, and diameter ratio of the impeller on the efficiency and pressure coefficient is discussed. The application of this method for computing the characteristic of a particular turbomachine is shown.

Multistage Radial Turbines, by P. F. Martinuzzi, Life Mem. ASME, Cornell University, Ithaca, N. Y. 1951 ASME Fall Meeting paper No. 51—F-15 (in type; to be published in Trans. ASME).

THERE are many applications of radial-flow turbomachines, but this paper deals particularly with radial turbines for gas-turbine use. The possibility of building a multistage inflow turbine of a type in which all of the rotors are carried on a single rotor disk is examined.

Single-Stage Radial Turbines for Gaseous Substances With High Rotative and Low Specific Speed, by W. T. Von Der Nuell, AiResearch Manufacturing Company, Los Angeles, Calif. 1951 ASME Fall Meeting paper No. 51—F-16 (in type; to be published in Trans. ASME).

THE turbine with radial inward flow, long known and in use as a water power plant, is rapidly gaining interest for gaseous energy carriers. Single-stage versions with wheels of shapes well known from aircraft-engine superchargers are now generally accepted in gas and air turbines when, relatively speaking, low mass flow in conjunction with high energy content per weight unit of the working substance characterize the available energy supply. Combining efficiency of 80 per cent and upward with attractive simplicity, this turbine type is bound to conquer its field. At present, aircraft auxiliary-power units represent its predominant application.

Some Theoretical Aerodynamic Investigations of Impellers in Radial- and Mixed-Flow Centrifugal Compressors, by J. D. Stanitz, Jun. ASME, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1951 ASME Fall Meeting paper No. 51—F-13 (in type; to be published in Trans. ASME).

THE purpose of this paper is to present the numerical results of several theoretical, aerodynamic investigations of impellers in radial and mixed-flow centrifugal compressors and to discuss the significance of these results with respect to improved compressor performance. The solutions are not intended to supply specific design information but rather to help create a general understanding and awareness of the flow conditions in impellers of centrifugal compressors.

The paper is given in two parts. In Part 1 two-dimensional relaxation solutions for compressible and incompressible fluids are presented for flow with axial symmetry (two solutions) and for flow between blades on surfaces of revolution about the axis of the impeller (eight solutions). The effect of variations in the following design and operating conditions of the impeller are investigated: (*a*) Compressor flow rate, (*b*) impeller-tip speed, (*c*) number of blades, and (*d*) blade curvature on flow surfaces of revolution. The numerical results are presented in plots of the streamlines, constant-velocity or Mach-number lines, and constant static-pressure lines. In Part 2 three approximate methods of solution are presented which can be used for relatively rapid analysis of compressible flow between blades on flow surfaces of revolution.

Materials Handling

Portable Conveyers in an Emergency Economy, by R. F. Tomlinson, A. B. Farquhar Company, York, Pa. 1951 ASME Fall Meeting paper No. 51—F-8 (mimeographed).

A PORTABLE conveyer is a conveyer that can be moved from one location to another, thereby widening its range of application. Specifically, it is a power-driven conveyer mounted on mobile supports.

It could be a belt conveyer, a chain and flight conveyer, a screw conveyer, or bucket conveyer. The mobile carriage on which it is mounted can be a self-propelled unit moving under its own power, or, as most frequently done, moved by manual methods or some outside source of power, such as towing by trucks or tractors. It could be 5 ft or 75 ft long, the average probably from 15 to 50 ft.

Originally designed about 1916, its development was comparatively slow for a number of years. However, it grew with the material-handling industry during the period of competition between manpower versus horsepower, and for the past ten years, with the tremendous shortage of unskilled labor, it has become an absolute necessity in the manufacturing and merchandising fields.

Uses of portable conveyers are numerous. For example, they can be moved from one end of a railroad siding to another; for unloading hopper cars, for storage of materials outside or inside the plant, or for use in processing the manufactured product. They can handle crates in one part of the plant, and component parts in other locations. This often leads, of course, to a whole battery of units operating in one plant according to requirements.

It becomes obvious, therefore, that when industry is suddenly called upon to make rapid conversions from a peace to war economy, as it was at the time of Pearl Harbor, and again in June, 1950, this type of material-handling equipment can jump into the breach. It takes months or even years for some industries to convert from a peaceful operation to an emergency one.

Large permanent materials-handling installations could cause serious slowdowns or shutdowns while being installed, but portable conveyers often can fill that gap with their versatility and flexibility.

These conveyers are sometimes even expendable, having paid for themselves more than once in their temporary assignment to certain jobs, but they are seldom condemned to the scrap pile. Sooner or later they can again be used for either permanent or temporary needs, and most units are in continuous daily operations for which they were purchased.

Instruments

Pyrometer Millivoltmeter and Automatic Controller, by E. W. Clark and J. K. Sidebottom, General Electric Company, West Lynn, Mass. 1951 ASME Fall Meeting paper No. 51—F-24 (mimeographed).

THIS paper describes a new electrical indicating instrument and automatic controller designed primarily for temperature applications in ranges varying from 0–300 F to 0–3000 F. For automatic control, internal contactors are used which permit direct control of either one or two circuits rated up to 10 amp at 120/240 volts if mechanical contactors are used, or rated 35/25 amp if mercury contacts are used. The instrument or controller may be modified to operate with any primary detector which provides a voltage output of 10 millivolts, or higher, at 48 microamp.

In appearance, the new pyrometer millivoltmeter controller combines attractiveness and utility. Its 7-in. scale length provides for ease and accuracy in setting and reading instrument pointers. The case, which is tightly gasketed to prevent dust, dirt, or chemical fumes from reaching the instrument mechanism, is suitable for either flush or surface mounting. The millivoltmeter is housed in the center of the case with a compartment for a control unit on either side.

Simplicity and ease of servicing were major considerations in the mechanical design of the new device. The control unit and millivoltmeter are both plug-in units which may be quickly and conveniently removed for checking or service. Entrance to the control compartment is gained simply by removing the front cover, thus providing easy access to the tube, tuning adjustment, balancing adjustment, and reset button.

ASME Transactions for October, 1951

THE October, 1951, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

Simplified Process for Determining Steam Purity, by S. T. Powell and I. G. McChesney. (50—A-85)

The Prevention of Embrittlement Cracking, by A. A. Berk. (50—A-84)

The Solubility of Quartz and Some Other Substances in Superheated Steam at High Pressures, by G. W. Morey and J. M. Hesselgesser. (50—A-73)

Stress and Deflection Tests of Steam-Turbine Diaphragm, by V. C. Taylor. (50—A-49)

High-Temperature Properties and Characteristics of a Ferritic Steam-Piping Steel, by A. W. Rankin and W. A. Reich. (50—A-76)

Effect of Molecular Weight of Entrained Fluid on the Performance of Steam-Jet Ejectors, by W. C. Holton. (50—A-114)

Effect of Temperature of Entrained Fluid on the Performance of Steam-Jet Ejectors, by W. C. Holton and E. J. Schulz. (50—A-115)

Turbojet-Engine Design for High-Speed Flight, by W. V. Hurley. (50—A-130)

Review of Combustion Phenomena for the Gas Turbine, by D. G. Shepherd. (50—A-96)

High-Speed Braking, by C. L. Eksergian.

Pressures Developed by Viscous Materials in the Screw Extrusion Machine, by W. T. Pigott.

Pressure-Temperature Relations in Gas-Filled (Class III) Thermometers, by E. E. Modes. (50—A-48)

The Pitot-Venturi Flow Element, by H. W. Stoll. (50—A-46)

A New Method of Determining Thermal Diffusivity of Solids at Various Temperatures, by D. Rosenthal and A. Ambrosio. (51—SA-39)

A Standard Laboratory Corrosion Test for Metals in Phosphoric-Acid Service, by H. F. Ebling and M. A. Scheil.

Coal Sampling by Large-Increment Weights, by B. A. Landry and W. W. Anderson.

The Integration of Organization and Management, by R. T. Livingston and D. B. Hertz. (51—S-1)

Analytical Studies in the Suppression of Wood Fires, by G. J. Tauxe and R. L. Stoker.

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Steamship Atlantic Seaman

COMMENT BY E. G. BAILEY[1]

To appreciate fully the importance of the progress made by the author of this paper[2] in all of his engineering work during the past 30 years, one must know at firsthand his methods. The features which he has incorporated in the Atlantic Seaman are typical of his constant desire for progress and use of the best means to fit the individual case.

The Van Dyke class of ship of 13 years ago has stood the test of time in justifying its many good features. The present design incorporates several of these feature, proved of value, but, in other particulars, changes and advanced steps have been taken. For instance, the author departs from general marine practice and uses recording meters to obtain certain important data aboard ship. He also has increased steam temperature beyond other marine designs, and has applied improved superheat control.

The author applies his observations, together with his memory of the prior art as well as of his own experiences, to analyze and evaluate all factors needed to solve any engineering problem, and thereby produce a result at less cost.

COMMENT BY M. L. IRELAND, JR.[3]

The author again has made a notable contribution to the progress of marine power in the design of a group of vessels which can claim many "firsts" to add to the pioneering record of his company.

The writer wishes to present some comparisons with another outstanding group of tankers, namely, the Esso supertankers, recently completed by this company.

With regard to power and speed performance based on trial results, the Atlantic Seaman required about 13,700 shp for a speed of 17 knots at her full-load displacement of 39,350 tons. The Esso tankers drove at 17 knots when using 12,300 shp at their full load displacement of 33,987 tons. Thus the Atlantic Seaman carried 15.8 per cent more tons at the same speed with about 11.4 per cent more power. These results are not far from the well-established approximation that shaft horsepower for a given speed varies as the two-thirds power of the displacement. It would thus appear that about equal amounts of ingenuity, skill, and know-how went into the selection of hull form lines and propeller design of the two vessels.

In the machinery plant there are larger differences since the steam conditions for the Esso tankers were 850 psi. 850 F at the superheater outlet with two drum-type boilers. Both vessels use four stages of bled steam for feed heating, though a slightly higher final feed temperature was used on the Atlantic Seaman. It is also noted that this vessel employs the further refinement of a drain cooler between the higher-pressure heaters and the deaerator. Also the make-up feed evaporators operate on the lowest available pressure-bled steam and exhaust to a fresh-water-circulated condenser, whereas the Esso-tanker arrangement uses an intermediate bleed pressure for this purpose, and the evaporated vapor is led to the first-stage feedwater heater.

In order properly to compare the fuel-rate performance of the two types of vessels, it is necessary to make certain corrections. The author has remarked about recently published fuel-rate results where galley, lighting, ventilating, and fresh-water systems were not clearly stated to be operating under normal conditions. Therefore the author's performance data will first be revised downward to correspond to the smaller electric load on the trials of the Esso tankers. A reduction in electric load from the author's value of about 420 kw to the 281 kw average for the Esso tankers brings the published fuel rate for the Atlantic Seaman down to a value of 0.48 lb per shphr.

In comparison the average rate determined from power and fuel measurements on three of the Esso tankers fitted with turbines designed and manufactured by the building yard was 0.498 as-run or 0.505 lb per shphr when corrected to design conditions.

Thus the Atlantic Seaman shows an improvement in fuel rate of approximately 5 per cent over the Esso tankers. This was accomplished principally as a result of the use of 170 F higher steam temperature.

It has been well established that the initial cost of such increases in temperatures are comparatively high and, to be justified, it appears necessary to make the most of them. Calculations which take into account the inherent improvement in turbine efficiency due to virtual elimination of moisture losses with the steam conditions used by the author indicate that about 6 per cent improvement in fuel rate over the Esso-tanker performance was to be expected.

A careful study of the heat balance presented in the paper, together with the author's statement of the main-engine steam rate, indicates that the difference between the stated and expected improvements in fuel rate may perhaps be found in the main-turbine performance.

One other factor may be of significance; it is noted that the boiler feed pump turbine-exhaust temperature is 750 F. It is well known that the use of highly superheated steam to heat feedwater results in appreciable thermodynamic loss. The writer would suggest that 1010 F steam temperature appears too high to be effectively used in a 250-hp turbine, and that a concession to the use of desuperheated steam might better be made in this instance.

The author has very ingeniously used the deaerator as a source of supply for fuel oil, bunkers, and quarters heating. These services are thus in effect supplied with saturated steam from the 40-lb gage crossover bleed point, whereas the initial temperature of 500 F leaving the turbine is too high for these services. No mention is made of the source for cargo oil heating, and it would be interesting to know from what source this steam is obtained and what means are

[1] Chairman of the Board, Bailey Meter Company, New York, N. Y.; and Vice-President, The Babcock & Wilcox Company, New York, N. Y. Fellow and Past-President, ASME.

[2] "S. S. Atlantic Seaman," by L. M. Goldsmith, MECHANICAL ENGINEERING, vol. 73, May, 1951, pp. 377–385.

[3] Assistant Chief Engineer, Newport News Shipbuilding and Dry Dock Company, Newport News, Va. Mem. ASME.

used to insure that it is sufficiently desuperheated.

The author's remarks concerning the main steam piping and particularly those regarding the splendid co-operation of the regulatory agencies are heartily seconded by the writer from personal experience. Only a few points seem to deserve elaboration: It would be interesting to know whether the author has found that cold pull-up is still in evidence when a pipe is unbolted after considerable service. Also, whether the author has observed that retightening of flange bolts after enough hours of service to permit the initial creep to take place has helped to keep the joints tight.

With regard to piping-design details, it is noted that main steam root valves were welded to the main header but flanged to the piping. The writer realizes that there is a well-established preference for flanged valves which can be removed for servicing, but wonders why in this case the valves were not also welded to the piping. The writer's own preference is for completely welded piping, except for the seemingly inevitable joints to permit lifting the top half of the turbine casing.

In conclusion, the writer can only comment with admiration on the many instances evident in the paper of the author's characteristic and original solutions of a wide variety of engineering design problems.

COMMENT BY CARL J. LAMB[4]

This paper will be of interest not only to merchant-marine engineers, but to central-station engineers and naval engineers as well, since the author's engineering of this new class of supertanker combines the latest and proved practice of the merchant ship, the naval vessel, and the central station. In addition, the author again has pioneered new and advanced design, as is usually the case when he brings out a new class of tanker.

Outstanding features of the Atlantic Seaman design are worthy of comment, and are seen as follows:

The use of an 11-in. dead rise, which permits satisfactory draining of cargo tanks by the main cargo pumps, eliminates the weight and cost of cargo stripping pumps, required by flat-bottomed tankers.

It is unfortunate, especially after such long and completely trouble-free service with five all-welded tankers over an 11-year period, that the American Bureau of Shipping and the U. S. Coast Guard forced the use of eight riveted longitudinal beams extending over three fifths of the vessel's length. Many engineers are convinced that a large part of the trouble, in the few cases of war-built welded-ship failures, was due either to improper design, improper welding, or both. The detail of the serrated design of all longitudinal frames on shell, deck, and longitudinal bulkheads is noteworthy, and undoubtedly will find wide future use.

The propulsion of the Atlantic Seaman, in general, follows latest practice as used by the merchant service, but with several noticeable exceptions, as follows:

1 It is unusual for large tankers, cargo ships, or passenger vessels to be propelled by only one engine, the practice generally being to use two engines driving twin screws, when full-speed power requirements exceed approximately 12,000 shp. It is obvious that one 16,500-hp turbine will consume less fuel than will two 8750-hp turbines, since the larger turbine will be more efficient, and for the same vessel speed, a twin-screw plant requires more power than does a single-screw one. Incidentally, the first cost of a twin-screw ship is appreciably greater than for the single-screw one of the same power.

2 This is the first ship to use 1020 F steam.

3 The great care taken to keep the gear case free of air. Back in 1921 Dr. Goldsmith did notable pioneering work along this line, and conducted experiments during a round-trip voyage of an Atlantic Refining Company tanker from Point Breeze to Mexico, keeping the gear case under a slight pressure of nitrogen.

4 The gain in main-engine water rate for the generation of auxiliary electric power, by driving a generator from the main-engine gear train.

The use of one central hydraulic pump to operate several different hydraulic motors driving deck machinery, at the same time, but at different loads and speeds, or to operate each independently. As stated in the paper, this is probably the first time such a system has been applied to all deck machinery aboard ship. Prior to the advent of the Atlantic Seaman, when hydraulic motors were used aboard ship, it was customary to apply one pump for each motor. The author, before developing such a flexible and advantageous system, evidently believed that anything can be done with a hydraulic system that can be done with an electric one, except make light.

The performance of the vessel as measured by fuel consumption was remarkable. A turbine designed for 16,500 shp, when developing 16,031 shp has a fuel consumption rate of 0.489 lb of 18,500 Btu bunker oil per shphr, or 9046.5 Btu per shphr at the propeller for all purposes. When it is considered that such a vessel as the Atlantic Seaman contains auxiliary machinery not required in a generating station, such as steering gear, gyrocompass, radio, radar, loran, galley ranges, living-quarter fans and ventilation, bilge pumps, fire pumps, refrigeration, sanitary pumps, with at least 10 per cent of the fuel burned being required for services not connected with the operation of the main plant, this fuel rate, to be compared properly to a central-station turbine generator then becomes 0.4401 lb of fuel per shphr or 8141.85 Btu per shphr at the propeller. Converting horsepower to kilowatts gives a Btu rate corresponding to 10,914 Btu per kwhr at the switchboard for a 12,500 kva turbine generator.

The author has performed a real service not only to the members of the Society, but to naval and merchant-marine engineers, in describing so completely the design of the Atlantic Seaman type of supertanker.

COMMENT BY ROBERT M. NALVEN[5]

The author has presented an excellent description of the characteristics and operation of this pioneering vessel. The writer was fortunate enough to be aboard during the maiden voyage, and familiarity with the plant creates the striking impression that here is an attempt to place aboard a floating power plant advanced features of modern central power stations. Based on this conception, the results now proved in service had already been established by sound engineering.

The use of recording charts as part of the extensive instrumentation is certainly a valuable development, evidence of which is neatly summed up in the chart reproduced in Fig. 12 of the paper. Continual technical analysis ashore tends toward establishing good operation and maintenance conditions not only during the initial period but after years of service and in spite of changes in operating personnel. Service problems can be studied based on recorded data instead of vague reports.

The author has described the steam generators for this vessel. A cross section of this unit may be of interest and is reproduced as Fig. 1, herewith.

[4] Carl J. Lamb, Captain USNR, Houston, Texas. Mem. ASME.

[5] Contract Engineer, Combustion Engineering-Superheater, Inc., New York, N. Y. Mem. ASME.

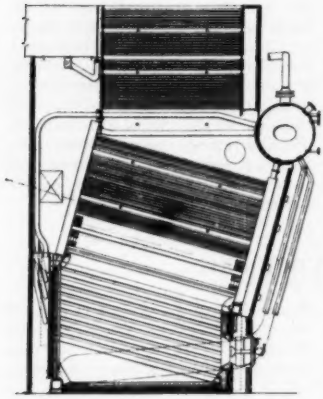


FIG. 1 CROSS SECTION OF STEAM GENERATOR

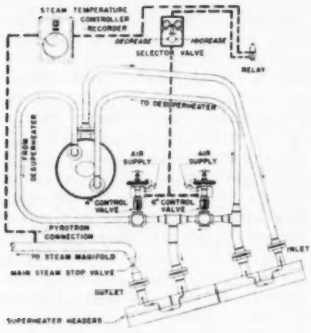


FIG. 2 ARRANGEMENT OF STEAM-TEMPERATURE CONTROL

It will be noted that it was possible to incorporate a superheater for the highest steam temperature in marine service in a conventional sectional-header boiler.

The author has emphasized the constancy of steam temperature under control, and it may be of interest to describe some of the features that make this possible. A diagrammatic arrangement is reproduced as Fig. 2 of this discussion. After passing through half of the superheater, all of the steam is removed. At this point part of it passes through a desuperheater in the drum and the remainder passes through a by-pass line. The portion of steam that is desuperheated mixes with the portion bypassed, and the total steam re-enters the second half of the superheater.

Control of the steam temperature is maintained by means of a 4-in. control valve in the desuperheater line and a 6-in. control valve in the by-pass line. A temperature element at the superheater outlet actuates these valves through the control system so that the mixture of desuperheated and by-passed steam results in a total steam temperature of 1020 F at the superheater outlet. A lower temperature can be set by a simple adjustment at the panel board, if desired.

The key to control sensitivity is that the superheater and desuperheater components of the steam generator are designed with temperature and pressure-drop characteristics such that, under normal conditions, the 4-in. control valve, the smaller of the two, controls the steam temperature, with the 6-in. control valve wide open. This results in a "micrometer" type of adjustment. Not until the steam temperature rises beyond the point of maximum operation of the 4-in. control valve does the larger 6-in. control valve come effectively into play.

Actual operation of this control system coincides exactly with the design prediction, with the result that 1020 F steam is obtained with the system floating on the 4-in. control valve, thus maintaining the constancy mentioned by the author.

Location of the steam-control point halfway through the superheater provides protection for the materials in the hot zone of the superheater, as well as for the turbine and piping.

AUTHOR'S CLOSURE

The author wishes to make some closing remarks in connection with the discussion of his paper, "SS Atlantic Seaman." He deeply appreciates the source and the nature of the comments, which require no rebuttal, with the exception of those made by Mr. Ireland.

Mr. Ireland makes a comparison with the Esso supertanker, which in general is favorable. However, he makes one incorrect statement: "Also the make-up feed evaporators operate on the lowest available pressure-bled steam and exhaust to a fresh-water-circulated condenser, whereas the Esso tanker arrangement uses an intermediate bleed pressure for this purpose, and the evaporated vapor is led to the first-stage feedwater heater."

Mr. Ireland is correct in that we used the lowest available bleed pressure for heating the evaporator, but he apparently misinterpreted our flow diagram, for we also used the feedwater to condense the evaporator make so that the evaporator condenser is operating as a first-stage feedwater heater. Mr. Ireland further comments that our auxiliary turbine generators are too small to efficiently utilize steam at 1010 F. This can be readily admitted as, in this case, we purposely sacrificed the slight gain in efficiency which could be obtained by desuperheating in order to avoid the complications which desuperheaters would require.

Mr. Ireland further states, "No mention is made of the source for cargo oil heating and it would be interesting to know from what source this steam is obtained." The answer to this is, of course, that no cargo heating is at present provided for on these ships. None was requested by our operating personnel. But space is provided for the future installation of a donkey boiler for this purpose and, if cargo heating is necessary, the donkey boiler would be installed in a self-contained heating circuit, so that there would be no danger of coil leakage getting into the main steam and condensate systems. This is the arrangement which we have used successfully on the high-temperature, high-pressure turbine-electric vessel, the *W. C. Yeager*, which was built 12 years ago.

It is also interesting to note that Captain Lamb agrees with us that the insistence on "crack stoppers" by the ABS and USCG was unfortunate and unnecessary in view of our *Van Dyke* experience. We, of course, agree with Captain Lamb. We believe that the insistence on the riveted joints was most unfortunate, particularly in the light of some of the more recent experiences on the T-2 type of turbine-electric ships in which crack stoppers were added.

The writer appreciates the extreme interest in this paper and also the opportunity to present it before our learned Society. He trusts that his little contribution will tend to further the art.

LESTER M. GOLDSMITH.[6]

Air Pollution

COMMENT BY SHEPPARD T. POWELL[7]

Any thoughtful reader of the author's excellent review[8] of the problems involved in the correction of atmospheric pollution and the fundamental causes responsible for their creation must be impressed by two outstanding factors: (*a*) Industrial management's responsibility to meet communal demands for clean air without inaugurating unwise corrective programs forced by mass hys-

[6] General Manager of Engineering and Construction, The Atlantic Refining Company, Philadelphia, Pa. Fellow ASME.

[7] Consulting Chemical Engineer, Baltimore, Md. Fellow, ASME.

[8] "Air Pollution—A Problem of the Process Industries," by A. G. Christie, MECHANICAL ENGINEERING, vol. 73, July, 1951, pp. 570-571 and 575.

teria. (*b*) A full realization that disposal of waste by-products, either into the atmosphere or into waterways, is an essential financial responsibility which must be paid as an operational obligation and, therefore, must enter into the price structure of product manufacturers.

Until recently there has been a woeful neglect of these two fundamental principles. A rational approach to a nation-wide correction of these problems must rest upon co-operative efforts by both industrial management and governmental groups. Without such mutual understanding and co-operation no realistic evaluation of community interest can be made.

Contamination of the atmosphere in urban areas is in no way the sole penalty of modern growth and development limited only to this country. In London, in the year 1273, sea coal was prohibited because it was believed prejudicial to human health, and even the smiths were obliged to burn wood. Later, a petition was presented to the London Council in 1578, by the Company of Brewers offering to use wood only in the breweries near Westminster Palace, as they understood that the Queen "findeth herselfe greately greved and anoyed with the taste and smoke of the sea-coales."[9]

The existing atmospheric conditions in all areas where industries exist is the natural sequence of concentration of such activity and the over-all development of new manufacturing processes and products not in existence at earlier times. As pointed out by the author, topographical and meteorological conditions and the magnitude and type of industries all have a vital bearing upon the type and degree of pollution which occurs. The catastrophic Donora incident graphically illustrates how all of these factors, when present simultaneously, can cause great disaster.

In many investigations with which we have been associated throughout this country and Canada, we have been impressed by the change in attitude of industrial management and their realization of need for cessation of bad practices which were formerly considered the penalty to be paid for industrial progress. In newly created industries or expansion of existing industries, necessary facilities for avoiding aerial pollution can be provided. However, in many old plants such correction is often difficult because of lack of space for the required facilities or the impracticability of their adoption to conform to existing manufacturing facilities.

We have found, many times, management's willingness to co-operate in avoiding pollution, but often no specific remedies are available. Granting industry's responsibility as the creator of contaminants, government, regardless of its level from the township to federal agencies, also has a specific responsibility not only to the people, but also to industry itself.

It requires no argument to convince anyone that our international place in the world today has been due in most part to our industrial growth and ingenuity. The solution of air-pollution problems, therefore, must not be forthcoming by stifling industries but by meeting this challenge for the control of atmospheric pollution through mutual understanding, tolerance, and guidance in correction of these difficulties rather than by ill-advised legislation.

Metal-Powder Parts

COMMENT BY RICHARD P. SEELIO[10]

Supplementing some points brought out in this paper,[11] it is usually recognized that structural parts, which require special dies and setups, should be produced in quantities larger than 10,000 pieces in order to realize the economic advantages of powder metallurgy. The fabricator, his customer, or the in-plant producer, as the case may be, is concerned with the amortization of the cost of the new die. He also has to consider the cost of designing this die, of setting it up, of making a trial run in some cases, of making further adjustments if indicated by this trial run, of die wear, of setting up for inspection of the product, and so forth. Thus the start-up burden of a new part is considerable, and usually a production run of at least 50,000, preferably 100,000 pieces, is indicated before powder metallurgy should be recommended as a competitive method.

In connection with die wear just mentioned, it is, of course, true that a powder-metallurgy die, which consists of several parts, does not wear out completely but that only certain parts of it will have to be replaced, or can perhaps be repaired. In the writer's experience, tool-steel-die life is subject to a great deal of variation, depending upon the steel selected, the heat-treatment, and the surface finish in the first place, and the care in the setup and the control of the production operation. An average die-life figure of 100,000 to 200,000 pieces seems to be adequate for most jobs, but where high precision is required or high pressures are used, removal of the dies from the presses for some sort of repair are more frequent.

The author makes the statement that iron parts can be hardened by standard methods or by variations of them, and Rockwell C values as high as 60 to 65 have been obtained consistently. It should be borne in mind that most powder-metallurgy products are porous, unless special treatments of some kind are used. Therefore the attainment of Rockwell C reading over 60 appears to be difficult simply because of the fact that the Rockwell brale sinks into the pores of the material and gives a lower reading. The matrix itself, of course, may be very hard if the proper composition and treatments are used, and the wear characteristics of such a material may be much better than normally indicated by the hardness reading.

It might be well to elaborate somewhat on the author's remarks concerning length-to-diameter ratios. In a part of the bushing type, a 0.050-in. wall may be considered a minimum for parts up to $^3/_4$ in. diam. This increases proportionately for large diameters. The ratio of wall thickness to length of a bushing-type part is also important. A minimum wall of $^1/_{32}$ in. for pieces up to $^3/_4$ in. long, $^1/_{16}$ in. for pieces $1^3/_4$ in. long, and $^1/_8$ in. up to $3^1/_2$ in. long are considered general rules which, of course, are subject to many exceptions depending upon materials used and properties desired.

Other design considerations such as tapers and fillets should be borne in mind as they affect the dimensions and assembly of a finished part. In this connection, tolerances of powder-metallurgy structural parts should be mentioned. One of the great advantages of this process is the ability to manufacture precision parts requiring, in some cases, no further machining. On the other hand, the closer the tolerances, the more expensive the product. Sometimes it is more economical to provide for a grinding operation. For details of the foregoing comments, the reader is referred to the ASTE Handbook.[12]

The author calls attention to the importance of avoiding feather or very thin

[9] "The Smoke Problem of Great Cities," by Sir Napier Shaw and John Switzer Owens, Constable & Company, Ltd., London, 1925, pp. 4–5.

[10] American Electro Metal Corporation, Yonkers, N. Y.

[11] "Some Design Aspects of Metal-Powder Parts," by D. C. Bradley, MECHANICAL ENGINEERING, vol. 73, February, 1951, pp. 123–127.

[12] Section 26, p. 456.

edges on punches and ejectors, and this is shown in his Fig. 10. In this connection it might be well to state that, in many cases where radii are formed, it is beneficial to redesign and to provide instead a chamfer with a small land giving strength to punch edges. Such a chamfer may be blended into the flat surface on the side opposite the land by means of a smooth radius. The sketch in Fig. 10 brings to mind the possibility of rather substantial density gradients as a result of pressing parts with curved surfaces. This can and often must be overcome by means of molding preforms which are later coined to the desired shape, or by using multiple punches which permit differential powder fill.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Marks' Mechanical Engineers' Handbook

MECHANICAL ENGINEERS' HANDBOOK. Edited by Lionel S. Marks. McGraw-Hill Book Company, Inc., New York, N. Y.; Toronto, Ont., Can.; London, England, 5th Edition, 1951. Fabricoid, 6 × 9 in., thumb-indexed, illus., index, xvii and 2236 pp., $15.

REVIEWED BY L. M. K. BOELTER[1]

THE preparation of a handbook to serve both "students and practicing engineers" represents a well-nigh impossible task. A general supposition is that students and professional engineers deal with knowledge from entirely different ends of the spectrum with some overlap and that the methodology, while similar in base, differs by virtue of the maturity of the application. The field of mechanical engineering presents an ever-expanding body of knowledge, thus the task of dropping the "old" and introducing the "new" requires the best in precise engineering thought.

Again, engineering students should be grounded in the behavior of physical and chemical systems (the phenomenology) and their numerical and algebraic description. The handbook, however, presents the data for engineering systems or components thereof (as should be the case). The student will find these data extremely valuable as a supplement to other sources and to observation.

The 2200 pages have been compiled by "over 100 experts, each a specialist in his field" as stated on the jacket; 82 are mentioned under the list of contributors while others who have prepared subsections are acknowledged in footnotes. The overlaps and the omissions and a slight lack of uniformity are readily traceable to the subdivision of labor practiced by the "specialist" in the "branch" of the "field of mechanical engineering." Needless to say many of the contributors are more than specialists; they are eminent engineers and educators. The task of the editor was gargantuan, his craftsmanship is superb, the handbook is worthy of his mind and pen.

The peripheral areas to the practice of mechanical engineering, overlapping other branches of the profession, such as electrical engineering, surveying, and others are covered with sufficient breadth to serve as general introductory reference material.

The format and typography are pleasing, representing a distinct improvement over the older editions. But a word of caution should be introduced; the physical size (approximately $6^1/_4 \times 9^1/_4 \times 2^3/_4$ in.) and weight ($4^1/_2$ lb) are considerations which the assiduous and continual user of a handbook will wish to consider. In contrast, the 26th edition of "Hütte des Ingenieurs Taschenbuch," was published in four volumes in 1931.

Throughout the course of the development of a large compilation of a subdivision of knowledge such as the Mechanical Engineer's Handbook, first published in 1916, many distinguished men have contributed material, form, and style. In the later editions their names no longer appear but a certain substance of their contribution remains. The reviewer has pondered the problem of credit to these engineers, but cannot conceive a solution other than that of general acknowledgment. This reviewer deems that criticism of detail would tend toward picayunishness. Several examples will be given in order to reveal the difficult task which the editor undertook. For instance, on page 1597, the reciprocal of the thermal conductivity ($1/k$) is called the internal resistance, although the term is the thermal resistivity. Again, on page 1676, a late work in acoustics of direct worth to professional engineers is "Acoustical Design in Architecture," by V. O. Knudsen and C. M. Harris, John Wiley and Sons, Inc., New York, N. Y., 1950, to which no reference is made. A final example, on page 115 the statement is made that "imaginary roots always occur in pairs if the a's are all real numbers," which is an amplification of the incorrect statement of the 4th edition (page 118), "Imaginary roots always occur in pairs"; a correct statement would read as follows: "If a root of the equation is complex its conjugate complex is also a root." Again, the chapter entitled "Vector Analysis" should be called "Vector Algebra."

Brief comments (far from complete) relative to the contents follow: 69 pages of the 2153 are devoted to mathematical tables which appear with practically no change compared with the 4th edition. The space devoted to orifices and the solution of pipe-line problems may be somewhat excessive while a great amount of basic data of direct value to the hydraulic design might have been included. The part of the section on heat dealing with basic thermodynamics is exceptionally complete. The proposal has been made that industrial applications of refrigeration could be well handled by reference to the Data Book (Applications Volume) of the American Society of Refrigeration Engineers. Reference to a later edition of the SAE Handbook than 1946 would be desirable under iron and steel, page 536.

While the handbook contains recent information on supersonic flow and nuclear reactors, the area of aircraft structures has been omitted.

Section 10 on hoisting and conveying represents an enlargement and revision, but it does not entirely reflect the progress made in materials handling during

[1] Dean, College of Engineering, University of California, Los Angeles, Calif. Fellow ASME.

the past 10 years. In this section and others it is the considered opinion of this reviewer that greater stress should be placed upon economic analysis.

The discussion of statistical quality control is brief and clearly presents the fundamental principles. However, a presentation of the art of sampling is omitted. A great number of additions and changes have been made in the 5th edition. These are summarized adequately on the jacket as: "Theory—Fluid mechanics, stresses in turbine disks, transonic and supersonic aerodynamics, aircraft jet propulsion, rockets, television; Processes—radiant or panel heating, solar heating, heating by heat pumps, compression, distillation, high-vacuum pumps, modern casting methods, industrial supersonics, automatic process control, etc.; Materials—ferrous and nonferrous alloys, superalloys for highest temperatures, plastics, elastomers, silicones, adhesives, explosives, rocket fuels, etc.; Power—gas turbines, atomic power."

Restricting further comments to only two areas: The chapters entitled Aeronautics, Transonic and Supersonic Aerodynamics, Aircraft Propellers, and Aircraft Jet Propulsion (pages 1470–1518) might well have been considered as Aerodynamics and Aircraft Propulsion. The art of aircraft and missile design has progressed greatly in the past years; the handbook should reveal these trends both in aerodynamics and propulsion.

The section on automatic control (No. 16) represents a good general treatment; however the modern analytical treatment of the behavior of control systems, including consideration of stability, has progressed far beyond the art as presented.

Rather than go on to appraise this work, which is stupendous and worthy, this reviewer will make one more general comment. The gap between fundamental knowledge and the practice of engineering must be kept as narrow as possible, remembering that contributions are made from both sides.

Marks' Handbook does contribute to shortening the gap but reference to current literature must always parallel its use in order that the handbook may be utilized to the maximum advantage.

Twenty-nine colleagues in the University of California and former students, all professors and professional engineers, undertook the arduous task of reviewing the handbook in detail for this reviewer. To them he is deeply grateful. Lack of space precludes publishing their penetrating and illuminating comments

The Water and The Power

THE WATER AND THE POWER: Development of the five great rivers of the West. By Albert N. Williams. Duell, Sloan, and Pearce, Inc., New York, N. Y., 1951. Cloth, 5¼ × 8¼ in., illus., 32 maps, bibliography, index, xiv and 378 pp., $4.50.

REVIEWED BY W. W. HORNER[2]

THE author himself has actively characterized this work in his preface by saying that the book was "to give a total impression rather than any complete detail," "give a brief and succinct history of the development of the five major Western rivers," and "to sum up the over-all problem of water supplies not only for the West, but for the entire nation."

Actually, the book divides itself naturally into two parts. The first or historical part is not only the story of the fascinating and important problem but is presented in an easy narrative fashion which makes it interesting reading. This part is to be recommended to anyone who would like to have a quick picture of the story of our five great western rivers[3] from discovery to present state of man-made development. He would probably find the beginnings of each chapter so intriguing that he will be unable to stop until the reading is completed.

In the second portion of the book, the author's summation consisting of chapter 7, entitled "A Future for America," is an entirely different matter. It presents the author's thesis as to the future responsibility of our natural resources. To those of us who agree with Dean Russell of the Foundation for Economic Education, that public ownership and operation of natural resources is communism, the author's conclusions can hardly be acceptable.

Nevertheless, the entertaining story of the five rivers, of their peculiar physical characteristics, of the romance of their discovery, of the amazing conceptions which have arisen as to the conservation and use of their waters, and particularly the clever account of the bickering and machinations between Federal agencies, States, and other groups, makes the book well worth reading.

To the reviewer the actual facts presented appear to be well founded, the interpretations of the facts often open to debate. As an example of the presentation, the chapter entitled "Old Muddy and Misery—The Missouri" is examined in somewhat more detail. In the beginning of this chapter the statement is made: "The Corps of Army Engineers has poured tax receipts by the hundreds of millions into the basin to construct a navigation channel from St. Louis to Sioux City without the vaguest assurance that the river contains enough water to fill their nine-foot channel. On the other side of the fence the Bureau of Reclamation has commenced work to irrigate an unknown number of acres of land on which it hopes that farming will be possible, and the Bureau knows no more than the Corps about the extent of the water supplies or the arability of the land."

Similar statements were made by the Task Forces of the Hoover Commission and were vigorously denounced by the Inter-Agency Committee. It may very well have stimulated the reanalysis of facts as just presented by the report of April, 1951, "Adequacy of Flows in the Missouri River," by the Missouri Basin Inter-Agency Committee.

Section 4 of this chapter, entitled "The Battle of the Armies," recounts the development of the Pick-Sloan Plan, and section 5—for the sake of comparison—reviews the beginnings and operations of the TVA. Subsequent sections are entitled "The Hydra-Headed Plan," "The Gangs Get Together," "The Pieces of the Puzzle," and "Welcome to Pick-sloania."

The author clearly has little trust in the Army Engineers and no particular belief in the Bureau of Reclamation, but there is evidence that he does recognize the ultimate responsibility in the Congress of the United States. "Concerning the proposed navigation developments, a set of similar grave problems present themselves, not only in the matter of questionable water supplies, but pertinent to the economic validity of the project." "Is it either economically or politically wise for Congress to authorize one federal agency, the Army Engineers, to spend countless millions for the sole purpose of forcing another federal agency, the Interstate Commerce Commission, to wipe out freight-rate inequities between various sections of the country?"

The author's review of the TVA development and his references elsewhere indicate that he does not consider the Regional Authority as the valid solution for water or other natural resources.

This general dissatisfaction developed

[2] Consulting Engineer, Horner & Shifrin, St. Louis, Mo. Chairman, Engineers Joint Council, Water Policy Panel.

[3] The Colorado, the Sacramento-San Joaquin, the Rio Grande, the Missouri, and the Columbia.

in the narrative chapters with both the basin Inter-Agency scheme and the Valley Authority forms the foundation for the author's own thesis in chapter 7.

He further concludes that this can best be accomplished by concentrating all natural resources, conservation, and development, including water and power, in a single federal department or bureau, and expands this idea further as: The role of the government in any such program should not be only that of taking over from private interests the beneficial use of water supplies and, where they pertain to water management, the forests, and range lands of the West, but rather to place at the disposal of industry the vast investment power of the federal government. This investment would enable our farmers to enjoy the best possible use of their lands, would give into industrial regions an inexhaustible supply of electric power at the lowest possible rate, and would serve to guarantee the future profitable use of public domain by livestock feeders."

To the reviewer this would appear not only a complete nationalization of power as the author proposed, but a rather complete control of all industry.

In conclusion, the reviewer would not have foregone the reading of the narrative chapters which he found an interesting and delightful experience. The author's conclusions are an entirely different thing: they parallel quite closely the findings of the President's temporary National Water Resources Committee in its recommended federalization of power, and one might even suspect that a possible preview of that report, or at least an idea of that probable conclusion, was the inspiration for the author's own paralleled solution. His solution would violate nearly all of the fundamental principles which Engineers Joint Council has indicated as underlying a desirable and sound national water policy.

Lubrication

LUBRICATION. Its Principles and Practice. By A. G. M. Michell. Blackie and Sons, Ltd., Glasgow, Scotland; London, England, 1950. Cloth, $6^1/_2 \times 9^3/_4$ in., tables, figs., plates, appendixes, references, index, folding diagrams hinged to front and back inside covers, xxi and 317 pp., 35s net.

REVIEWED BY D. F. WILCOCK[4]

THE author, an international authority on lubrication, states that the primary aim of this book is to serve both the practicing engineer and the student. While it is not a conventional textbook in that only so much theory as is necessary to support the argument is included, and problems and numerical examples are not included, this book will probably be of greater service to students than to practicing engineers.

Mr. Michell approaches the practical lubrication problem with the maximum possible use of theory. While this can be an important and fruitful approach for one specializing in the field of lubrication, it offers little of concrete comfort to the engineer who has bearings and lubricants as only one of many responsibilities and interests. The examples cited are almost entirely of British or European practice, and are quite general in nature. Automobile and aircraft lubrication is specifically excluded.

Considerable space is devoted to physical properties of lubricants and their flow through spaces such as capillaries and between flat plates, and to the viscometry of lubricants. Then the chapters take up in turn: sliding bearings; thrust bearings and some other plane sliding bearings; journal bearings; rolling bearings; lubrication of gears, piston rings and pivots; distribution and treatment of lubricants in service; and conveyance of lubricants in systems of distribution and circulation.

The author holds to the view that "boundary lubrication" is largely if not entirely explainable on the basis of the simultaneous occurrence of solid-contact friction between the "rugosities" of the rubbing surfaces and viscous-fluid action. This theory is developed quantitatively, in an appendix representing original work, as an explanation of the rise in friction coefficient at very low values of the Sommerfeld number. The role of polar or chemically active compounds is not discussed. The author mentions other original material, hitherto unpublished, as contained in several of the chapters, but modestly refrains from indicating its location clearly.

This book is recommended to those who are interested in British practice and views in the field of bearing design, and to those who may profit from a viewpoint refreshingly different in many cases from our own.

[4] Engineer, Bearing and Lubricant Center, Thomson Laboratory, The General Electric Company, West Lynn, Mass. Mem. ASME.

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

Books Received in Library

ADVANCED FLUID DYNAMICS AND FLUID MACHINERY. By R. C. Binder. Prentice-Hall, Inc., New York, N. Y., 1951. Linen, $5^1/_2 \times 8^1/_2$ in., 426 pp., illus., diagrams, charts, tables, $8. An extension of the author's "Fluid Mechanics," this book bridges the gap between introductory and advanced works on the subject. Part 1, entitled "Fluid Dynamics," covers one-dimensional compressible flow, flow with friction and heat transfer, and boundary-layer flow. Part 2, "Fluid Machinery," is concerned with common machines and gives illustrations or applications of material previously studied. The third and last part, "Fluid Dynamics," deals with somewhat more complicated flows than those considered in Part 1. Selected references and problems follow most chapters.

ADVANCES IN APPLIED MECHANICS. Volume 2. Edited by R. von Mises and T. von Kármán. Academic Press, Inc., New York, N. Y., 1951. Cloth, $6 \times 9^1/_4$ in., 233 pp., diagrams, charts, tables, $6.50. The second volume in a series, this book surveys the present state of research work in various fields of applied mechanics. It consists of papers on the following topics: statistical theory of isotropic turbulence, laminar boundary layer in compressible flow, the bending of curved tubes, recent developments in inverse and semi-inverse methods in the mechanics of continua, and the theory of filtration of liquids in porous media.

AIRCRAFT JET POWER PLANTS. By F. P. Durham. Prentice-Hall, Inc., New York, N. Y., 1951. Cloth, $5^3/_4 \times 8^1/_2$ in., 326 pp., illus., diagrams, charts, tables, $6.65. This book deals with aircraft jet power plants with special emphasis on the gas turbine. The first six chapters are devoted to jet propulsion and gas-turbine principles. The next five chapters each deal with a component of the jet engine. The remaining two chapters present the fundamentals of ramjets and rockets. The compressible gas flow theory is developed throughout the book wherever its application is necessary. A knowledge of elementary thermodynamics and fluid mechanics is essential, and a knowledge of elementary aerodynamics is desirable although not essential.

BIBLIOGRAPHY OF STATISTICAL QUALITY CONTROL. Supplement. By G. I. Butterbaugh. University of Washington Press, Seattle, Wash., 1951. Paper, 6×9 in., 141 pp., $2. A supplement to the 1946 "Bibliography of Statistical Quality Control," this volume covers the period from 1946 through June, 1949, and lists approximately 725 items. It contains references to periodical literature, manuals, monographs, pamphlets and books on such topics as sampling, correlation, significance tests, design of experiments, analysis of variance, the theory of runs, frequency distributions, control charts, inspection, and probability. Author and subject indexes to both the original bibliography and this supplement are included.

ENGINEERING METROLOGY. By K. J. Hume. Macdonald & Co., Ltd., London, England, 1950. Cloth, $5^1/_2 \times 8^3/_4$ in., 293 pp., illus., diagrams, charts, tables, 18s. Dealing with the application of metrology in the field of mechanical engineering, this book is of interest to those concerned with precision measurement in production, inspection, toolroom or standards-room work. Both theoretical and practical aspects of engineering dimensional measurement are considered. Descriptions of typical modern instruments, apparatus, and methods are included. A working knowledge of mathematics, including trigonometry and algebra and some knowledge of applied mathematics, mechanics, and physics is assumed.

GAS TURBINE MANUAL. By R. J. Welsh and G. Waller. Temple Press, Ltd., London, England, 1951. Cloth, $5^1/_2 \times 8^3/_4$ in., 243 pp., illus., diagrams, charts, tables, 25s. Intended as a text for students and a reference for power-plant engineers, this British book deals with various forms of gas turbines other than those used for aircraft. It covers fundamental theory and operational features of turbines used in locomotive, power station, and marine applications. A glossary of gas-turbine terms, useful tables, and bibliography are included. Design information on some 50 British and foreign gas-turbine plants is also given.

GAS TURBINES AND JET PROPULSION. By G. G. Smith. Fifth edition. Aircraft Books, Inc., New York, N. Y., 1951. Cloth, $5^1/_2 \times 8^3/_4$ in., 393 pp., illus., diagrams, charts, tables, $7.50. This book surveys historical development, explains basic principles and theories involved, and summarizes design characteristics of complete units and components. In this fifth edition, new material includes a chapter dealing with the application of gas-turbine power to road transport, expanded sections describing metallurgical progress, combustion systems, the recent development of exhaust reheat or afterburning, and a world-wide review of turbine-propelled aircraft and their power units.

HIGH-TEMPERATURE PROPERTIES OF METALS. By E. R. Parker and Associates. Published by American Society for Metals, Cleveland, Ohio, 1951. Fabricoid, $6 \times 9^1/_4$ in., 176 pp., illus., diagrams, charts, tables, $4. This volume contains five lectures on the following subjects: creep of metals, stress-rupture testing, high-temperature fatigue testing, methods of high-temperature oxidation testing and evaluation of observations, and some experiences in power, oil, and chemical plants. All but the last paper are followed by lists of references, and an index to all five is included.

INTERPRETATION OF TESTS AND CORRELATION WITH SERVICE. By M. F. Garwood and Associates. American Society for Metals, Cleveland, Ohio, 1951. Cloth, $6 \times 9^1/_4$ in., 198 pp., illus., diagrams, charts, tables, $5. This volume contains four lectures which were presented at the Thirty-Second National Metal Congress, in Chicago, Ill., in October, 1950. The first paper discusses laboratory tests on automotive components and indicates that a definite correlation between test results and service performance exists. The second paper considers the limitations of mechanical testing. In the third paper, the results of wear tests and service performance are investigated. The last paper deals with corrosion tests and their relation to service performance. References are given at the end of the first, third, and fourth pages, and an index is included to all four.

LIQUID EXTRACTION. By R. E. Treybal. McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Cloth, $6 \times 9^1/_4$ in., 422 pp., diagrams, charts, tables, $7.50. This book reviews and organizes the subject matter of the unit operation of liquid extraction. It covers such phases of the subject as its physical chemistry, prediction of equilibria, thermodynamics of nonideal solutions, choice of solvent, diffusion in liquids, and a theoretical discussion of mass transfer. The design of extraction systems, including a description of equipment and operating characteristics, is presented as well as a brief review of modern chemical processes using liquid extraction.

MACRAE'S BLUE BOOK. Fifty-eighth edition, 1951. MacRae's Blue Book Company, Chicago, Ill., 1951. Cloth, $8^1/_4 \times 11^1/_4$ in., 4098 pp., illus., $15 in U. S. A.; $20 foreign. Revised annually, this book is one of the most useful listings of manufacturers, and materials of all kinds. It has four sections: address and local distributors' section, classified material section, chemical section, and trade-name section.

POLYPHASE COMMUTATOR MACHINES. By B. Adkins and W. J. Gibbs. Cambridge University Press, American Branch, New York, N. Y., 1951. Linen, $5^1/_2 \times 8^3/_4$ in., 230 pp., illus., diagrams, charts, $4. Written by designers for students and engineers, this book describes the various types of polyphase commutator machines, including the most important methods of control and the characteristics obtained. Stressing the practical side, theory is dealt with in separate sections. A good prior knowledge of induction-motor theory is needed for those interested in the theoretical treatment.

TABLES RELATING TO MATHIEU FUNCTIONS, prepared by the Computation Laboratory of the U. S. National Bureau of Standards; published by Columbia University Press, New York, N. Y., 1951. Cloth, $8 \times 10^3/_4$ in., 278 pp., tables, $8. Continuing the series of specialized mathematical tables and computational helps, the present volume provides characteristic values, coefficients, and joining factors for Mathieu functions on which comparatively little has been previously published. The tables are carried out to from 7 to 9 decimal places. A brief treatment of the use of these functions and of the method of preparation of the tables is given in the introduction.

VIBRATION AND SHOCK ISOLATION. By C. E. Crede. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, Ltd., London, England, 1951. Linen, $6 \times 9^1/_4$ in., 328 pp., illus., diagrams, charts, tables, $6.50. This book is written to provide the practicing engineer with a rigorous, yet practical, reference work on the design and application of resilient mountings. It is concerned with the basic mechanics of isolation and includes practical discussions on the design and application of isolators. Chapter 1 is devoted to basic mathematical and physical concepts; chapters 2 and 3 to fundamental principles of vibration and shock isolation; chapter 4 to nonlinear and damped systems, practical aspects of damper design, and sound isolation; chapter 5 to the properties of materials used as isolators and to the design of isolators that employ these materials; the last chapter discusses many specific applications of isolators, both industrial and military.

ASME BOILER CODE

Proposed Revisions and Addenda to Boiler Construction Code

As need arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code. Simple changes are indicated directly. In the more involved revisions added words are printed in SMALL CAPITALS; deleted words are enclosed in brackets [ ].

Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers 1949

PAR. P-180 Replace entire paragraph with the following:

P-180 *Shells for Internal Pressure.* (a) When the thickness of the shell does not exceed one-half of the inside radius, the maximum allowable working pressure on the cylindrical shell of a boiler or drum shall be determined by the strength of the weakest course computed from the thickness of the plate, the efficiency of the longitudinal joint, or of the ligaments between the tube holes in the shell or drum (whichever is the least), the inside radius of the course, and the maximum allowable unit working stress, using formulas under (b) or (c).

(b) Where the shell thickness is $^1/_2$ in. or less, or where staying is required, or where other conditions do not comply with limitations of (c), the following formulas shall be used:

$$P = \frac{0.8\,S\,E\,t}{R + 0.6\,t} \quad \text{or} \quad t = \frac{PR}{0.8\,SE - 0.6\,P}$$

where

P = maximum allowable working pressure, pounds per square inch.

S = maximum allowable unit working stress, pounds per square inch, taken from Table P-7 (as published in MECHANICAL ENGINEERING, August, 1951).

E = Efficiency of longitudinal joints or of ligaments between openings:
for riveted joints = calculated riveted efficiency
for fusion-welded joints = efficiency specified in Par. P-102
for seamless shells = 100 per cent (unity)
for ligaments between openings, the efficiency shall be calculated by the rules given in Pars. P-192 and P-193.

t = minimum thickness of shell plates in weakest course, inches.

R = inside radius of the weakest course of the shell or drum, inches.

(c) Where the shell thickness exceeds $^1/_2$ inch, for shells and headers of seamless or fusion-welded construction, and which do not require staying, the following formulas shall be used

$$P = \frac{SE(t-0.1)}{R+0.6(t-0.1)} \text{ or } t = \frac{PR}{SE-0.6P} + 0.1$$

where symbols are the same as in (b).

Stresses due to hydrostatic head shall be taken into account in determining the minimum thickness of the shell, head or header. Additional stresses imposed by effects other than working pressure or static head which increase the average stress over substantial sections of the shell, head, or header by more than 10 per cent of the allowable working stress shall be taken into account. These effects include the weight of the drum or header and its contents, and method of support. Also all weld reinforcements on both inside and outside of the plates at the longitudinal and circumferential seams shall be removed substantially flush with the surface of the plate.

(d) The maximum allowable working pressure for shells other than cylindrical, and for heads and other parts, shall be determined in a similar manner using the formulas appropriate for the parts, as otherwise given in the Code.

(e) When the thickness of the shell exceeds one-half of the inside radius, the maximum allowable working pressure on the cylindrical shell of a boiler or drum shall be determined by the formulas in Par. A-125.

PAR. P-195 (a) Revise formula to read:

$$t = \frac{5\,PL}{4.8\,S\,E}$$

Revise definition S to read:

S = Maximum allowable working stress, pounds per square inch, using values given in Table P-7, (as published in MECHANICAL ENGINEERING, August, 1951)

PAR. P-195 (i) Revise second paragraph to read:

Head thicknesses obtained by using formula in Par. P-195 (1) for hemispherical heads and Par. P-195(g) for blank semi-ellipsoidal heads do not apply to heads with pressure on the convex side.

PAR. P-195 (1) Replace the one formula with two formulas as follows:

$$\text{(A)} \ldots\ldots t = \frac{PL}{1.6\,SE}$$

$$\text{(B)} \ldots\ldots t = \frac{PL}{2\,SE} + 0.1$$

Add Paragraph:

Use formula A; however, formula B may be used for heads exceeding $^1/_2$ in. in thickness that are to be used only with shells or headers designed under provisions of Par. P-180(c) and that are integrally formed on seamless drums, or are attached by fusion welding, and that do not require staying. Where formula B is used the other requirements of Par. P-180(c) shall also apply.

Revise definition of "S" as follows:

S = Maximum allowable working stress, pounds per square inch, using values given in Table P-7 (as published in MECHANICAL ENGINEERING, August, 1951).

PAR. P-198 (a) Replace the one formula with two formulas as follows

$$\text{(A)} \ldots\ldots t = d\sqrt{\frac{CP}{0.8S}}$$

$$\text{(B)} \ldots\ldots t = d\left[\sqrt{\frac{CP}{S}} + 0.1\right]$$

Add paragraph:

Use formula A; however, formula B may be used for heads exceeding $^1/_2$ in. in thickness, that do not require staying. Where formula B is used the requirements of Par. P-180(c) also apply.

Revise definition of "S" as follows:

S = Maximum allowable working stress, pounds per square inch, using values given in Table P-7, (as published in MECHANICAL ENGINEERING, August, 1951)

PAR. P-268(a) Replace the one formula for "K" with two as follows

$$\text{(A)} \ldots\ldots K = \frac{PD}{1.6\,St}$$

$$\text{(B)} \ldots\ldots K = \frac{PD}{2\,St}$$

Revise first paragraph after definition as follows:

In determining the maximum size of an unreinforced opening in a shell, head, or header use formula A for K except that, where the shell, head or header is designed under P-180(c), the value of K shall be 1.1 times the value of K computed by the formula B for the part of the shell head, or header that contains the opening. When computing K by the formula B, the pressure P shall be that for which the part is designed, S shall be the stress value from Table P-7 (as published in MECHANICAL ENGINEERING, August, 1951), and t shall be the actual full thickness of the shell at the location of the opening, including the 0.10 inch additive thickness. Where K so computed is unity or greater, the maximum size of unreinforced openings shall be 2 in.

PAR. P-325 (c) Revise end of last sentence of first paragraph to read:

For tension and compression, 32 per cent, and for shear, 26 per cent, of stress values given in Table P-7 (as published in MECHANICAL ENGINEERING, August, 1951), multiplied by the welded joint efficiency specified in Par. P-102.

Par. A-30 & A-32 Revise formula as follows

$$P = \frac{0.8\,HS}{E}$$

Revise description of "S" as follows:

S = Working stress, pounds per square inch permitted by Tables P-5 and P-7 (as published in MECHANICAL ENGINEERING, August, 1951) and P-6 for the material at the maximum operating temperature as determined by code requirements.

Par. A-125 Revise description of "S" as follows:

S = maximum allowable working unit stress, pounds per square inch, taken from Table P-7 (as published in MECHANICAL ENGINEERING, August, 1951).

Add note at end:

NOTE: 0.10 inch is to be added to the thickness thus determined and restrictive requirements of P-180(c) also apply to this paragraph.

Corrections

The corrections below should be made in Appendixes 1 and 2 to the Revisions of the Boiler Construction Code as they appeared in the August 1951, issue of MECHANICAL ENGINEERING on pages 674 to 676 and are additional to the Errata printed on page 763 of the September issue. All of these corrections have been incorporated in the loose leaves for Case No. 1143 as distributed to subscribers to the ASME Boiler Code Interpretations.

TABLE P-2. In the column headed "Nearest Bwg No." change the figure opposite the wall thickness "0.200" from "6" to "6-".

TABLE P-4. In footnote[1] change "exceed" to "exceeds."

APPENDIX 2. Change titles of tables to read: ALLOWABLE STRESS VALUES FOR TABLES P-5 AND P-7

In the section for Plate Steels make the line for specification SA-285, grade C the last line of this section.

In the section for Alloy Steels put "SA-" before each specification number. Below "SA-315" insert "SA-213 T12," with a bracket to connect both to type "1.0 Cr 0.50 Moly." Below "SA-158 P5b" insert "SA-213 T13" with a bracket to connect both to type "5Cr 0.50 Moly Si." Delete "SA-158 P5c" and "SA-213 T14" and the line to which they relate.* Opposite "SA-301" change the minimum tensile from "70,000" to "65,000"; the figures in the next six columns from "17,500" to "16,250" and "16,900" to "15,650," "15,000" to "14,400" and "12,750" to "12,500." (The last two figures are unchanged.)

In the section on Austenitic Alloys, in both the upper and lower halves, add a column for "Spec."; insert "SA-213 Tp. 304, SA 240 Gr.S, and SA-158 P8a," bracketed together to relate them to the first two lines of materials "18 Cr 8 Ni (TS)" and "18 Cr 8 Ni (YS)"; in like manner insert "SA-213 Tp. 347," "SA-240 Gr. C.," and "SA-158 P8d" to apply to "18 Cr 8 Ni Cb," "SA-213 Tp. 321," "SA-240 Gr.T.," and "SA-158 P8b" to apply to "18 Cr 8 NiTi," and "SA-213 Tp. 316" and "SA-240 Gr. M" to apply to "16 Cr 13 Ni 3 Mo." Add to the footnote: "Otherwise use values given under YS."

* This voids the correction given in the second paragraph of the Errata printed in the September, 1951, MECHANICAL ENGINEERING.

THE ENGINEERING PROFESSION

News and Notes

As Compiled and Edited by A. F. Bochenek

EJC Manpower Program Well Received at Pittsburgh Convocation

A PROGRAM for better utilization of engineering and scientific personnel and for increasing the flow of high-school graduates to the engineering schools was presented to more than 400 industrial personnel directors, high-school counselors, and engineering educators from 28 states at a convocation held at the Stephen Foster Memorial Hall, Pittsburgh, Pa., Sept. 28, 1951.

The convocation was sponsored by the Engineering Manpower Commission of the Engineers Joint Council with the co-operation of the Engineers Society of Western Pennsylvania and the ECPD Guidance Committee.

The purpose of the convocation was to alert engineering leaders at the community level to organize local programs of information and guidance and to convince the general public of the vital importance of technical manpower to the American way of life.

That the convocation achieved its purpose was evident from the earnestness with which delegates from widely scattered industrial centers participated in the convocation program and discussions and from the volume of mail being received by the Engineering Manpower Commission headquarters in New York. This correspondence is from convocation delegates who want key individuals in their community to be placed on the EMC mailing list to receive the convocation proceedings.

Already delegates from Connecticut and Kentucky are planning a state-wide convocation to carry the EMC program to industrial communities in the state. The Los Angeles delegation has informed the Commission that it is using local engineering organizations to instruct counselors at the high-school level how they can contribute to the relief of the engineering manpower shortage. M. S. Coover, head, electrical-engineering department, Iowa State College, Ames, Iowa, reported that the Midwest region of the ECPD Guidance Committee plans to carry the EMC program to communities in the states of Illinois, Iowa, Minnesota, Missouri, Nebraska, North and South Dakota, and Wisconsin.

Morning Session

As the first speaker, A. C. Monteith, vice-president, Westinghouse Electric Corporation, Pittsburgh, Pa., stressed the part played by engineers in the national economy and warned that the public must understand this "basic ingredient" supplied by engineering personnel, and must encourage young enterprising people to study for scientific and engineering careers.

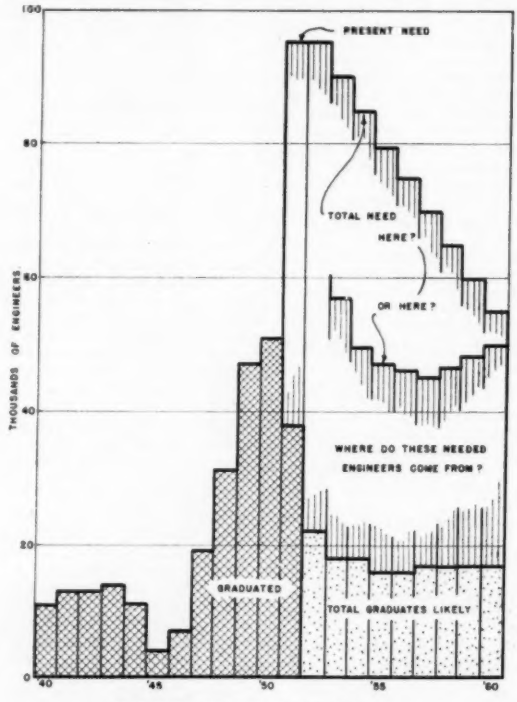
S. C. Hollister, dean of engineering, Cornell University, Ithaca, N. Y., discussed the shortage of engineers from a statistical point of view.

The Federal Government has been exceedingly slow in recognizing manpower as one of the nation's most critical problems, M. H. Trytten, National Research Council, Washington, D. C., told the delegates in a talk on "Government Agencies and Policies." Recently, he said, the National Manpower Policy Committee and an Advisory Committee on Specialized Personnel in the Office of Defense Mobilization was established. How effective these agencies will be only time can tell. It was his conviction, Dr. Trytten said, that a satisfactory solution to the manpower problem will be likely only if engineering and scientific societies remain alert to the problem and are properly organized to assist the government in arriving at satisfactory solutions and aiding in implementing decisions when they are made.

As the final speaker of the panel, Carey H. Brown, chairman, Engineering Manpower Commission, of the EJC, defined an approach to a practical solution for engineering manpower problems. The full text of Mr. Brown's remarks appears on pages 910–912 of this issue.

Prolonged Discussion Followed Talks

The afternoon session was devoted to a free discussion period during which questions from delegates were answered by a panel of experts composed of: Carey H. Brown, C. S. Dargusch, S. C. Hollister, A. C. Monteith, Ben Moreell, P. N. Powers, M. H. Trytten, J. C. Warner, and Douglas Brown.



THE CRITICAL SHORTAGE OF ENGINEERS

(Prepared by S. C. Hollister from data compiled by the U. S. Bureau of Labor Statistics, U. S. Office of Education, American Society for Engineering Education, and Engineering Manpower Commission of the Engineers Joint Council.)

The economic status of engineers, status of women engineers, use of retired engineers, and the immigration of engineers from foreign countries were some of the problems discussed by the delegates. In answer to a question on the use of overtime in solving the engineering shortage, Admiral Ben Moreell felt that overtime in itself could not solve the problem because of diminished efficiency when people worked too long.

Time and again the discussion returned to economic status and the effect of the inducement of high salaries upon young men choosing careers. It was the consensus that while compensation was important, it was not the whole answer to recruitment. Young men, one speaker said, should be inspired to feel that there was something beyond compensation to aspire to and that "just being an engineer in itself" was a wonderful thing.

Many of the questions touched on the relation of women to the manpower shortage. The consensus was that women engineers could help the situation but that there was a social attitude militating against preprofessional training in engineering for women. Even when women are educated as engineers, problems in placing them in plants have to be met. Generally, employers are willing to accept women when they can employ them.

The recruitment of graduate engineers in foreign countries was suggested, but the panel stated that it was difficult to arrange such a move without consulting the immigration authorities. While many foreign engineering students would like to augment their training in American industry, they are needed in their own countries. The U. S. should not solve its own problems by weakening the technology and industry of war-devastated countries.

Engineers who wish to participate actively in the EJC manpower program should communicate immediately with the chairman of the local section of their professional engineering society and offer to organize a committee for this purpose.

EJC Drafts Statement on Salaries for U. S. Salary Stabilization Board

PREMIUMS for scheduled overtime and correction of salary inequities created by high starting salaries and the wage and salary freeze were some of the recommendations made to the U. S. Salary Stabilization Board by the Engineers Joint Council. The recommendations were part of a statement requested by the Salary Stabilization Board to assist it in establishing wage-stabilization regulations.

Dr. Raymond B. Allen, chairman of the Salary Stabilization Board, explained at a preliminary conference with EJC representatives on Aug. 6, 1951, that the Board would welcome a statement of the problems of wage stabilization from the point of view of the engineer.

Joseph Cooper, executive director of the Board, said that the request to the EJC was, in effect, a valuable pilot project which would be useful in resolving inflationary problems encountered by other groups. The Board, he said, chose the EJC for this purpose because it felt that engineers could be counted on to take a long view of the problem.

The following statement was drafted by representatives of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, The American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Chemical Engineers, the American Society for Engineering Education, and the EJC Engineering Manpower Commission:

Problems in Salary Stabilization

1 The increase in the industrial and technical load to prepare the nation's economy for defense has resulted in an unusual and sudden demand for engineers which has created many inequities and imbalances in engineering salaries.

2 Engineers are in short supply. The situation will get worse and there is no immediate solution in sight. Immediate alleviation can come only by more rapid advancement of those who show capacity for broadening their activities and assuming additional responsibilities. Adequate salary treatment in such cases is imperative.

3 The normal process of development of the engineer from graduation includes a period of training in industry and progressive growth to increased responsibility in all phases of engineering practice.

4 One of the inherent difficulties in comparing the values of engineering services is the difficulty in describing or classifying the skills that are used. As the engineer advances in experience, he is able to grasp engineering problems and evolve engineering designs more quickly, the volume of the work he produces increases, and yet he may continue to hold the same job designation he had when he started his work.

5 Not only does an engineer become more productive as he gains experience, but actually the contributions of each individual vary widely depending on his creative ability, training, and other personal characteristics. Therefore, in the absence of a plan which provides for promotion of an engineer from one arbitrary job classification to another, each merit increase may be, at least partly, a promotion increase and must be made on the basis of an appraisal of the individual's growth and contribution to the business.

6 More recent graduates are needed than are available. This shortage has led to the payment of increased starting salaries by many employers at rates that are materially above the rates the same employer was paying before 1950. Experienced engineers also are in short supply and many are underpaid.

7 The justifiable increases in starting rates for engineers that have been made effective since 1949, have in many cases flattened the previous experience-salary curves. This is because employers have not always made increases in the compensation of experienced engineers in proportion to increased starting rates. This has resulted in serious inequities as between salaries of older engineers and salaries of those just starting their careers.

8 Differentials which normally exist between engineering (and executive salaries and those of nonexempt employees with whom they are associated (draftsmen, clerks, mechanics, etc.) are either materially reduced or disappear altogether when, in a period like the present, industry finds it necessary to operate on schedules in excess of forty hours per week. This is particularly true of the younger or lower-paid professional employees and executive employees. Overtime payment practices for exempt employees vary widely between companies. The Salary Stabilization regulations should be amended to permit the payment of premiums for scheduled overtime to exempt employees not to exceed the treatment given nonexempt employees in the same organization.

9 Certain segments of the engineering profession were at abnormally low salary levels at the time of the salary freeze. A serious loss of technical personnel in these elements of the economy is being created because of their depressed salary rates. Methods must be provided to permit the equalizing of salary rates to obtain a balanced distribution of professional personnel in all phases of engineering service in the national economy.

10 To minimize the tendency of engineers to shift from one organization to another due to the factors enumerated above, with resulting loss of productivity, it is believed that prequalification should be required of contractors, whether for engineering services, construction, or supply. In addition, as recommended more specifically below, opportunity should be afforded to employers to compensate their engineers fairly and adequately, thereby permitting those organizations that are essential to national health, welfare, and defense of the country to maintain their professional staffs.

11 All these considerations lead to the following recommendations of Engineers Joint Council, representing a membership of 130,000 engineers, that the regulations of the Salary Stabilization Board should permit:

(*a*) Correction of salary inequities created by the current high level of starting salaries of young engineers so as to permit commensurate increases of salaries for older, qualified, and well-experienced engineers.

(*b*) Correction of salary inequities in areas where engineering salaries were abnormally low at the time of the wage and salary freeze.

(*c*) Clarification of Section 8 (6) *e* of Circular GSSR No. 1 to indicate flexibility of treatment of so-called "rare and unusual cases" as concerning engineers because of the existing serious manpower shortage of engineers.

(*d*) Appropriate salary increases for professional employees and others in cases where responsibilities vary with the competencies of individuals, and where the job classifications are impracticable.

(*e*) Premiums for scheduled overtime to exempt employees not to exceed the treatment given nonexempt employees in the same organization.

JAMES M. TODD, President,
Engineers Joint Council

EJC Supports Proposed Tax-Exemption Bills

SUPPORT of legislation now before both houses of Congress which provides for certain tax exemptions for income contributed by professional persons to approved retirement plans was expressed recently by the Engineers Joint Council. In a letter signed by James M. Todd, president, EJC, legislators were informed that the engineering profession was concerned about "the evident inequities of existing tax laws as they affect the possibilities for professional people . . . to provide adequately for old-age retirement."

Pending legislation favored by EJC is covered by the amendment to the Revenue Act of 1951, HR 4473, proposed by Senator Irving M. Ives of New York, the bill introduced by Congressman E. J. Keogh, HR 4371, and the bill HR 4373, introduced by Congressman C. W. Reed. Each of the three bills, which are substantially the same, grant certain tax exemptions for income contributed to an approved retirement plan. The annual contribution could be either 10 per cent of earned income or $7500, whichever is less. Participants could not withdraw contributions before the age of 60 except in case of total and permanent disability.

The legislation also provides that upon retirement individuals could make withdrawals either in a lump sum or in installments and amounts withdrawn would then be subject to appropriate income taxation. As a third method of benefit, it would be possible for a participant to use retirement funds to purchase a retirement policy from an insurance company.

These legislative bills, long supported by bar associations, are designed to protect the professional man whose annual income varies greatly. During high income years such an individual could set aside for retirement purposes sums of money which would otherwise be turned over to the government because of high income-tax rates in the higher brackets.

EJC Urges Reconsideration of Cut in Science Foundation Funds

IN A telegram to the chairman of the Appropriations Committee of the U. S. Senate, the Engineers Joint Council urged "careful reconsideration by the Senate of the $300,000 appropriation voted by the House Committee on Appropriations for the National Science Foundation." The EJC urged that a sufficient sum be made available "for effective operation of the Foundation."

The EJC telegram was prompted by the action of the House of Representatives which reduced President Truman's budget request for the National Science Foundation by 98 per cent, from $14,000,000 to $300,000.

In a statement following House action, Alan T. Waterman, director of the Foundation, said that the House appropriation would force a drastic curtailment in the Foundation's program of support of basic research in the training of scientific manpower.

"For fiscal year 1952, the National Science Foundation requested $5,060,000 for the support of about 2100 graduate fellowships in the sciences and engineering, Dr. Waterman stated. These fellowships will make it possible for young college graduates, who lack the means, to begin graduate studies and to become fully trained operating scientists and engineers. By this item alone—by insuring the supply of trained scientific and engineering manpower—the National Science Foundation will make a unique and invaluable contribution to the present emergency.

"Research support has equal bearing on the emergency. Today, the time-lag between the discovery of a basic scientific principle and its exploitation and application has all but disappeared in great technological areas, many of significance to defense. In field after field—aircraft design, jet-engine metallurgy, guided-missile development, liquid-fuel production, military medicine, atomic power—technical progress is seriously delayed by lack of basic knowledge."

The National Science Foundation was established by Congress and the President on May 10, 1950, after four years of study and 1200 pages of testimony by authorities on science, education, medicine, and engineering. The Engineers Joint Council was instrumental in advising Congress on phases of the legislation and the President on appointments to the Foundation Board. For operational and administrative expenses for the last year, Congress appropriated $225,000. The legislation authorized a maximum budget of $15,000,000.

Thorndike Saville, dean of engineering, New York University, New York, N. Y., has assumed chairmanship to the EJC Committee on Engineering Sciences made vacant by the death of Boris A. Bakhmeteff, and presented the progress report of the committee on which EJC took the action noted.

Engineering Education Can Benefit From Humanities AIChE Hears

BETTER engineering education lies not so much in the direction of technical specialization as it does in (1) improving the communication powers of engineering graduates, (2) stressing by example and insistence the honesty and integrity of engineering practice, and (3) the addition of a course in common sense.

This is the opinion of J. H. Boyd, visiting professor of Columbia University, New York, N. Y., who spoke at a round-table discussion on engineering education at a recent meeting of the American Institute of Chemical Engineers.

Dr. Boyd stated that a broad training based on scientific fundamentals was the best curriculum developed to date. The undergraduate curriculum did not permit thorough training of undergraduates in a professional specialty. The graduate school and actual work in industry were the proper places for specialization.

Other speakers commented on the improvement during the past few decades in engineering education. Speaking of the chemical-engineering curriculum, G. G. Brown, dean, college of engineering, University of Michigan, Ann Arbor, Mich., stated that 60 per cent of the schools offering a chemical-engineering curriculum are accredited by the American Institute of Chemical Engineers and the Engineers' Council for Professional Development. In 1925, he said, only 21 per cent of the schools could meet the accrediting standards.

Industry can contribute greatly to the quality of engineering education by increasing summer jobs for teachers and students and by calling in engineering teachers as consultants, W. T. Nichols, director, general engineering department, Monsanto Chemical Company, St. Louis, Mo., stated.

Plans for Centennial Year of Engineering Are Under Way

HERBERT HOOVER, Charles F. Ketterling, and B. F. Fairless, will be some of the speakers featured during the Centennial of Engineering to be held in Chicago, Ill., July 1–Sept. 30, 1952, to celebrate the founding of the American Society of Civil Engineers, the oldest American professional engineering society.

The centennial will have a dual character to enable the general public as well as the engineering profession to participate in commemorating the first century of engineering in America.

In addition to the program of technical events in which 41 national and international engineering bodies will participate, the program will include a pageant depicting engineering progress through the centuries and a permanent exhibit of inventions which have contributed to the comfort and convenience of modern living.

Some 30 technical engineering societies, including The American Society of Mechanical Engineers, will hold meetings in Chicago in honor of the Centennial. The high light of the program will be a general convocation, Sept. 3–12, during which eminent engineers from both hemispheres will participate in symposiums on education and training, world food supply, transportation, mining, chemicals, communications, energy, structures and construction procedures, health, and urbanization.

It is expected that discussion of these world topics will be presented in terms that will be meaningful to the educated layman.

Throughout the summer the pageant will call attention to the engineering episodes that have contributed to human progress. These will include the perfection in ancient times of the first wheel, the building of the Roman Appian Way, and other incidents of engineering progress ending with the harnessing of the atom for peacetime purposes.

The third feature of the Centennial, the permanent exhibit, will be open to the public free of charge the year round and will continue for five years.

Original inventions, models, and dioramas will be utilized to show the evolution of engineering.

OFFICERS OF PARTICIPATING SOCIETIES IN THE CONFERENCE OF ENGINEERING SOCIETIES OF WESTERN EUROPE AND THE UNITED STATES OF AMERICAN (EUSEC)

(*Left to right, first row:* Brian G. Robbins, secretary, The Institution of Mechanical Engineers, United Kingdom; Graham Clark, secretary, Institution of Civil Engineers, U. K.; C. E. Davies, secretary, The American Society of Mechanical Engineers, U. S. A.; W. N. Carey, secretary, American Society of Civil Engineers, U. S. A.; W. G. Brasher, secretary, The Institution of Electrical Engineers, U. K.; Georges Ville, secretary, Societe des Ingenieurs Civils de France; *second row:* Jorgen Saxild, president, Engineering Society of Denmark; Oskar Akerman, managing director, Engineering Society of Sweden; Haakon Eeg-Henriksen, president, Engineering Society of Norway; H. Sterky, general director, Engineering Society of Sweden; *back row:* P. E. Soutter, general secretary, Engineering Society of Switzerland; Ed. Hianne, administrative secretary, Belgium Royal Society of Engineers and Industrialists; Bjarne Bassöe, general secretary, Engineering Society of Norway; H. Sangster, general secretary, Dutch Society of Engineers; H. H. Henline, secretary, American Institute of Electrical Engineers, U. S. A.)

Four Engineering Societies Admitted to EUSEC at September Meeting

THE conference of representatives from the Engineering Societies of Western Europe and the United States of America met at The Hague, the Netherlands, Sept. 16–20, 1951. Nine countries were represented by the following officers of engineering societies:

Holland, the host country: O. C. A. van Lidth de Jeude, president; F. Q. DenHollander, vice-president; Th. R. Seldenrath, member of council; and H. Sangster, secretary.

Belgium: Société Royale Belge des Ingénieurs et des Industriels, M. Berger-Hainaut, first vice-president; Ed. Hianné, administrative secretary.

Denmark: Dansk Ingeniørforening, Jorgen Saxild, president; and Niels Lichtenberg, general secretary.

Finland: Joint Council of Suomalaisten Teknikkojen Seura and Tekniska Föreningen i Finland, Ilmari Voionmaa, chairman, Finnish Association, and Gunnar Hernberg, chairman, Swedish Association.

France: Société des Ingénieurs Civils de France, P. Chevenard, president; and G. Ville, general delegate.

Norway: Den Norske Ingeniorforening, Haakon Eeg-Henriksen, president, and Bjarne Bassöe, general secretary.

Sweden: Svenska Teknologföreningen, Hakan Sterky, general director, and Oskar Akerman, managing director.

Switzerland: Schweizerischer Ingenieur-und Architekten-Verein, P. E. Soutter, general secretary.

United Kingdom: The Institution of Civil Engineers, W. H. Glanville, president; and E. Graham Clark, secretary. The Institution of Mechanical Engineers, A. C. Hartley, president, and Brian G. Robbins, secretary. The Institution of Electrical Engineers, Sir Archibald Gill, president, and W. K. Brasher, secretary.

The United States of America: American Society of Civil Engineers, William N. Carey, executive secretary. The American Society of Mechanical Engineers, C. E. Davies, secretary. American Institute of Electrical Engineers, F. O. McMillan, president, and H. H. Henline, secretary.

The conference, early in its deliberations, decided that its designation was cumbersome and adopted EUSEC as an abridged name. The conference took several actions to strengthen the organization.

1 Voting to admit four bodies: (*a*) American Institute of Mining and Metallurgical Engineers; (*b*) American Institute of Chemical Engineers; (*c*) Verein Deutscher Ingenieure; (*d*) Associazione Nazionale d'Ingegneri e Architetti Italiani.

2 Adopting working relations between EUSEC and the Conference of Engineering Institutions of the British Commonwealth and the Union of Pan-American Engineering Societies.

3 Providing for more frequent interchange of information between the participating societies.

EUSEC took cognizance of the recent establishment of a body, primarily European, which provides some duplication of activities.

500 Engineers Attend AEC Symposium at Oak Ridge

AMERICAN industry is benefiting in countless ways from the engineering knowledge "beyond handbook limits" which is being made available by the national atomic-energy program, T. Keith Glennan, commissioner, U. S. Atomic Energy Commission, told an audience of some 500 engineers and scientists who participated in the third annual Oak Ridge Summer Symposium on Atomic Energy held recently at Oak Ridge, Tenn. The symposium was the first of the series to be devoted to engineering.

For two weeks the delegates discussed the theme, "The Role of Engineering in Nuclear Energy Development." The symposium was conducted by the Oak Ridge National Laboratory and the Oak Ridge Institute of Nuclear Studies under the sponsorship of the American Society for Engineering Education.

Production of power and plutonium with specially designed reactors seems feasible, according to S. H. Schurr, chief economist of the U. S. Bureau of Mines. Dr. Schurr's comment was based on a reactor unit which was substantially a conventional power plant producing power with "costless" fuel. The engineers were told that reactor technology was developing much faster due to the pressure of military demands. Another incentive to progress was the prospect of successful breeding to increase nuclear fuel supply. The continuing demand for fissionable materials was making by-product power production more promising.

Major problems in nuclear engineering, another speaker said, were materials development, equipment design, fuel and production processing, and control and safety requirements. The mechanical engineer's responsibility in contributing to nuclear energy development will be in the construction of reactor components and in the design of such equipment as valves and heat exchangers to meet unprecedented engineering conditions.

From the test program on reactor materials such as new metals and alloys, liquid-metal coolants, refractory metals, ceramics and metal-ceramics, a better understanding of how these materials will behave under high-temperature conditions, was being obtained. In the field of heat transfer much attention was being given to liquid metals and fused salts but a great deal of information about physical properties of these materials was necessary before many of the heat-transfer problems could be solved.

In a discussion of radioactive-waste problems, one speaker warned that development of disposal methods must parallel advances in reactor development if a troublesome bottleneck was to be avoided. The Commission and its contractors have been successful in disposing of radioactive wastes without creating hazards to plant personnel or people living in the vicinity of current operations.

Complete transactions of the symposium will be published by the AEC technical information services. This document (TID-5031) will be available for a nominal charge after Dec. 1, 1951, from the Office of Technical Services, Department of Commerce, Washington 25, D. C.

World Leaders in Heat-Transfer Studies Hold Discussions in London

A HIGHLY successful General Discussion on Heat Transfer was held in London, Sept. 11–13, 1951, under the auspices of The Institution of Mechanical Engineers and The American Society of Mechanical Engineers, with 674 engineers and scientists participating. Of those attending, about 50 came from continental Europe and 20 from the United States and Canada.

In arranging the meeting, the sponsoring Societies brought into co-operation some 51 societies concerned with the engineering and scientific problems of heat transfer from Great Britain, Western Europe, and the British Commonwealth, as well as from the United States and Canada. In the United States a committee on North American co-operation made up of the following representatives was organized: American Chemical Society, Walter Lobo; American Institute of Chemical Engineers, T. B. Drew; American Institute of Physics, Mark Zemansky; American Mathematical Society, Eric Reissner; American Physical Society, Arthur Kantrowitz; American Society of Heating and Ventilating Engineers, L. P. Saunders; The American Society of Mechanical Engineers, John A. Goff; F. G. Hechler, A. L. London, and J. I. Yellott; American Society of Refrigerating Engineers, C. M. Ashley; The Engineering Institute of Canada, E. A. Allcut; Institute of the Aeronautical Sciences, T. V. Charyk; and Society of Automotive Engineers, G. J. Huebner.

Chairman of the committee was A. P. Colburn and A. C. Mueller served as secretary.

In Great Britain the work was handled by an executive committee for the Institution of which Prof. O. A. Saunders was chairman.

Dignified Ceremony Opened Discussions

The discussion was opened in a brief, dignified ceremony on Sept. 11, by A. C. Hartley, Mem. ASME, president, The Institution of Mechanical Engineers, with the support of the two chairmen, O. A. Saunders and A. P. Colburn. At the technical sessions 93 papers were presented, the work of about 140 individual authors—61 originating in Great Britain and Europe and 32 in North America. Papers were arranged in five groups and a session was devoted to each group. Two co-chairmen—one from Great Britain and one from North America—presided over each session. The reporters from Great Britain presented the European papers on each subject and the North American reporters presented those originating in North America.

Following is a list of the subjects, the co-chairmen and the reporters:

Heat Transfer With Change of State: *Co-chairmen:* Europe, Sir Geoffrey I. Taylor; U. S. A. and Canada, E. A. Allcut; *Reporters:* Europe—R. A. Smith; U. S. A. and Canada, A. C. Mueller.

Heat Transfer Between Fluids and Surfaces: *Cochairmen:* Europe, Exer Griffiths; U. S. A. and Canada, A. L. London; *Reporters:* Europe, H. S. Arms; U. S. A. and Canada, Byron Short.

Conduction in Solids and Fluids: *Cochairmen:* Europe, O. A. Saunders; U. S. A. and Canada, W. E. Lobo; *Reporters:* Europe, Mrs. M. Fishenden; U. S. A. and Canada, Carl Kayan.

Radiation, Instrumentation, Measurement Techniques, and Analogies: *Cochairmen:* Europe, R. W. Bailey; U. S. A. and Canada, L. P. Saunders; *Reporters:* Europe, A. W. Scott; U. S. A. and Canada, K. Wohl.

Special Problems: *Cochairmen:* Europe, D. M. Newitt; U. S. A. and Canada, H. L. Dryden; *Reporters:* Europe, J. F. Alcock; U. S. A. and Canada, G. M. Dusinberre.

At the closing session, presided over by President Hartley, discussion was held on important matters which seemed to require additional discussion. One of these, a matter of broad interest, was the difficulty described by designers of heat-transfer equipment of using the results of experimental research under laboratory conditions. There was general agreement that active steps should be taken to bring the work of the research worker closer to the needs of the designer.

A. P. Colburn Is Clayton Lecturer

The engineering high light of the meeting was the presentation of the Clayton Lecture by Prof. A. P. Colburn who reported on his research in heat transfer and the relation of his results with design data.

The stern technical character of the meeting was relieved by the reception and conversazione on the opening evening at which

AT THE RECEPTION AND CONVERSAZINE HELD DURING THE GENERAL DISCUSSIONS ON HEAT TRANSFER IN LONDON
(*Left to right:* A. Clifford Hartley, president, The Institution of Mechanical Engineers, Mrs. Hartley, the Honorable William L. Batt, past-president ASME, and head, Economic Cooperation Administration for Great Britain, and Mrs. Batt.)

President and Mrs. Hartley of The Institution were joined in the receiving line by past-president William L. Batt of ASME and Mrs. Batt. The closing dinner, under the genial chairmanship of President Hartley, provided an opportunity for words of appreciation and good will from the many groups who were represented in the discussion. The delegation from the United States was outspoken in its views about the success of the discussion, particularly as an opportunity to become acquainted with the leaders in the field from Europe and Great Britain.

The Heat Transfer Division of ASME is planning to re-present the papers at the Atlantic City ASME meeting in November. Written discussions are being requested in the hope that they will be ready at Atlantic City and can be included in the final proceedings of the meeting which will be published during the spring. (See page 953.)

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CO-CHAIRMEN AND REPORTERS FOR THE GENERAL DISCUSSIONS ON HEAT TRANSFER HELD IN LONDON, SEPT. 11–13, 1951

Session 1 (*left to right*): A. C. Mueller, E. A. Allcut, Sir Geoffrey I. Taylor, and R. A. Smith; (2) Session 2, H. S. Arms, Ezer Griffiths, A. L. London, and Byron Short; (3) Session 3, Carl Kayan, W. E. Lobo, and O. A. Saunders, Dr. Margaret Fishenden (not shown); (4) Session 4, K. Wohl, L. P. Saunders, R. W. Bailey, and A. W. Scott; (5) Session 5, J. F. Alcock, G. M. Dusinberre, and D. M. Newitt, and H. L. Dryden; (6) C. E. Davies, O. A. Saunders, Sir Henry Guy, A. P. Colburn and Brian G. Robbins. (These photographs were taken in the Stephenson Room in the Headquarters of The Institution of Mechanical Engineers in London.)

ASME News

Automatic Control Engineers Hold Discussions in London

SOME 300 engineers and scientists from Norway, Sweden, Holland, France, Germany, Switzerland, Britain, Canada, and the United States took part in the 1951 Conference on Automatic Control sponsored by the Department of Scientific and Industrial Research of Great Britain and held at the Royal College of Aeronautics, fifty miles north of London, England, July 16–21, 1951.

H. L. Mason, professor of mechanical engineering, Iowa State College, Ames, Iowa, represented the Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers at the Conference. Other ASME members who participated were W. H. Howe, chief engineer, The Foxboro Company, Foxboro, Mass., who presented a paper on "Some Recent Developments in Process Control," and G. M. Muschamp, vice-president in charge of engineering, Minneapolis-Honeywell Regulator Company, Philadelphia, Pa., who took part in the discussion.

A Notable Event

The conference was notable, Dr. Mason said, for the presence of both servomechanism and process-control engineers from many countries; for developments reported in analysis of nonlinear systems; and for the imaginative demonstration of the thesis that economic problems might be approached by way of the techniques of the feedback loop. British engineers, he noted, were active in the mathematical and the experimental aspects of automatic control.

According to Dr. Mason, the Department of Scientific and Industrial Research is a governmental enterprise established in 1916 which resembles the National Science Foundation of the United States. It is headed by a secretary of cabinet rank, Sir Ben Lockspeiser, and operates directly the Chemical Research Laboratory, National Physical Laboratory, Road Research Laboratory, and a Telecommunications Laboratory. The Department co-operates with industrial firms in supplying funds and direction to research associations in such diverse industries as baking, coal, cotton, internal-combustion engines, iron and steel, nonferrous metals, jewelry, electric machinery, printing and packaging, and wool.

Co-Operating Agencies

The Department, in co-operation with the Naval Scientific Service, Medical Research Council, Ministry of Supply, Military College of Science, University of Birmingham, The Institution of Mechanical Engineers, The Institution of Electrical Engineers, the Scientific Instrument Manufacturers Association, and Imperial Chemical Industries, Ltd., organized the technical program of the conference. In addition to the technical sessions, many of the delegates attended the British Instrument Industries Exhibition held in London, July 4–14, 1951.

According to Dr. Mason, 8 or 10 papers were presented and discussed by the delegates each day with time out for refreshments.

Broad Technical Coverage

A session on education heard Dr. Gordon S. Brown of Massachusetts Institute of Technology, Cambridge, Mass., issue a challenge to use industry-sponsored research to train students capable of grasping the mathematical, mechanical, electrical, chemical, and hydraulic aspects of the control loop, and of engineering the composite system as a whole.

Sessions on linear theory discussed criteria for defining stability in the complex plane, the use of relative damping tables to evaluate characteristic roots, the relation of frequency band width to rapid response and to minimum error, the distribution of time constants among rotary generators, an electrolytic tank analog, plots of log mod and phase shift for damped oscillation, the application of the Wiener-Lee theory on stationary time functions, and the use of difference operators to optimize response when random disturbances are superposed on the signal.

Process-control sessions heard reports on an Imperial Chemical Industries conference between chemical and servomechanism engineers, frequency response characteristics of pneumatic controllers, the effect of transmission and measuring lags in the loop, new definitions of controller action, a compensator for pneumatic transmission, the choice of controlled variable, and distributed parameters in shell-and-tube heat exchangers.

A day devoted to nonlinear problems brought out a comparison between step-by-step, iterative, perturbation, and topological methods; some new theorems in Lagrangians; linearizing by a periodic sweep signal; velocity-squared feedback for on-off controls; useful applications of nonlinearity; perturbation in two speed-control problems; jerking motion in a positional control; and an analytic-graphic treatment of backlash and resilience.

At sessions on intermittent action, discussion concerned the choice of parameters for systems required to deliver a smooth output, a comparison of finite-difference with differential operators, free versus spring-loaded joysticks for manual tracking, a mathematical model for manual tracking, conformal transformation of the system polynomial as a criterion for stability of systems under deviation-dependent control, comparison of such systems with continuous ones by using the deviation integral, and minimizing oscillation in systems with contactor and reversing motor.

There were also papers on a versatile electrohydraulic governor for water turbines, a general method of analyzing a servo transmitting a carrier wave superposed on a-c signals, matrix theory applied to analysis of national income and expenditure, and a graphical representation of the economic structure as a feedback loop.

Experimental Devices Add Interest

Many of the authors brought with them the experimental devices described in their papers. Demonstrations of these and related exhibits were systematically toured by the conference members in small groups in free evenings or late afternoon. Social events included a reception by the parliamentary secretary of the Board of Trade, and a farewell dinner at which national groups found a new unity in paying tribute to Prof. Arnold Tustin, the tireless chairman of the conference organizing committee.

Proceedings of the conference are to be published by Butterworths Scientific Publishers, Bellyard, Temple Bar, London WC 2.

Support for Joint ASTM-ASME Research Projects Sought

A CAMPAIGN to raise $85,000 to finance four research projects in the field of high-temperature metallurgy was inaugurated recently by the Joint Committee on the Effect of Temperature on the Properties of Metals, sponsored by the American Society for Testing Materials and The American Society of Mechanical Engineers. A brochure and a letter soliciting funds has been sent to leading organizations concerned with the problems under study by the Joint Committee.

The four projects for which the committee seeks funds are: (1) Statistical Evaluation of Creep-Rupture Properties of Certain Sheet Materials (Aviation Panel); (2) Effect of Stress Concentration on Fatigue of Metals at Elevated Temperatures (Gas Turbine Panel), (3) Collection, Compilation, and Publication of High-Temperature Data (Data and Publications Panel); (4) Elevated Temperature Properties of Cast Iron (Steam Power Panel, in Co-operation with ASTM Committee A-3 on Cast Iron).

Committee's Projects Reviewed

The brochure, prepared under the direction of the Finance Committee headed by Norman L. Mochel, Mem. ASME, Westinghouse Electric Corporation, Philadelphia, Pa., in co-operation with the Joint Committee chairman, Ernest L. Robinson, Fellow ASME, General Electric Company, Schenectady, N. Y., states that the four projects will require about $65,000. In addition, several thousand dollars are needed immediately for the completion of work already under way and in order to avoid another approach for funds in the near future. The committee has asked for about $20,000 for future projects.

The brochure gives a short historical statement and notes some of the accomplishments and publications of the committee. They include: standard methods, bibliographies, extensive symposiums, engineering data and compilations, reports, and many sponsored technical papers.

The current activities covered by formal

agreements include work on graphitization, effect of manufacturing variables on creep resistance, and high-temperature data compilations.

Co-Operative Activities

The committee has numerous research projects which do not require allocation of specific funds, the work being contributed by committee members and their companies and handled in other ways. From these co-operative activities come many benefits, including important data on problems in the field. Some ten projects are included in this category as follows: Exploratory Investigation of High-Temperature Sheet Materials for Aircraft Applications; Compilation of Experiences With Metals Above 1500 F; Behavior and Application of Metal at Low Temperatures; Relative Merits of 18 per cent Chromium, 8 per cent Nickel, and Stabilized Grades of Austenitic Steels; Necessity for Preheating and Stress-Relieving Ferritic Steels Welded With Austenitic Rods; Cracking at Welds of 12 per cent Chromium Liners in Pressure Vessels; Experience With Corrosion by Vanadium Compounds; Effect of Stress Concentration Factors on Rupture Life; Effect of Surrounding Atmosphere on Creep of Metals; and Spread in High-Temperature Properties of Grade B Pipe to ASTM A 106, and in Plate to ASTM A 212.

The committee has undertaken only four fund-raising campaigns (1927, 1930, 1936, and 1939) to which industry and The Engineering Foundation subscribed a total of something over $60,000. With this modest sum the committee has sponsored a large volume of research since 1927. At the same time, it has focused metallurgical attention on areas needing research, and catalyzed contributions-in-kind (donated services, materials, and equipment) equivalent to manyfold the actual cash donations. At the present time, no unobligated balance remains from its last appeal initiated eleven years ago and from interim Foundation grants. Contributions for Joint Committee projects are deposited in a special custodian account administered for the two sponsor societies by ASME and are expended only on authority of the Joint Committee.

Cooling Tower Institute Formed

A NEW trade association, the Cooling Tower Institute, was organized in January, 1951, by seven manufacturers of industrial water-cooling equipment to aid in the dissemination of technical data among users of such equipment. Membership in the Institute, whose headquarters is in Basking Ridge, N. J., is open to companies engaged in the manufacture and sale of water-cooling equipment. Five technical subcommittees are currently active in such fields as acceptance test procedure for cooling-tower equipment, recirculation problems, wood-maintenance problems, water conservation, and standardization within the industry.

The Institute plans to co-operate with professional societies in the advancement of water-cooling-tower technology.

Raymond C. Kelly is president of the Institute. W. A. Shoudy, Fellow ASME, is executive manager.

ECA Surveys West German Research Resources

A GROUP of American scientific research authorities headed by Harold Vagtborg, Mem. ASME, president, Southwest Research Institute, San Antonio, Texas, recently undertook an exhaustive survey of West Germany's scientific research resources under ECA sponsorship.

In addition to staff members from Southwest Research Institute, the group, which spent a month in Europe with headquarters at Bonn, Germany, and Paris, France, included top research officials from Armour Research Foundation, Chicago, Ill., Battelle Memorial Institute, Columbus, Ohio, and Stanford Research Institute, Palo Alto, Calif.

Primary objective of the survey was to determine whether a need existed for establishment of applied research institutes to serve small and medium-sized manufacturers and processors in West Germany in the interest of national security and, if it did, how best to set up such laboratories.

ASHVE Moves to New Offices

THE American Society of Heating and Ventilating Engineers moved its headquarters last month from 51 Madison Avenue to larger quarters at 62 Worth Street, New York, N. Y. The change was made because of the growth of the Society's membership which has virtually tripled in the past decade. The new offices occupy the entire fourth floor of the Worth Street building recently renovated and air conditioned.

The location is near Broadway in the vicinity of the New York Municipal Building. This is the third time ASHVE has moved its headquarters. From 1911 to 1930 society offices were in the Engineering Societies Building, New York, N. Y. During this period membership increased from 400 to 2000. Since 1930, membership has increased to more than 8000. The Worth Street offices, with nearly double the floor space of the Madison Avenue address, will enable the society to meet the requirements of a large and active membership.

Canada Seeks Immigration of Engineers

CANADIAN employers have accepted a proposal by The Engineering Institute of Canada that its secretary visit England for the purpose of seeking qualified engineers who would be willing to take positions in Canadian industry.

This approach to Canada's critical engineering manpower shortage has the approval of the Canadian Departments of Labor and Citizenship and Immigration as well as the co-operation of the British Institutions of Civil, Electrical, and Mechanical Engineers.

Meetings of Other Societies

Nov. 14–17
The Society of Naval Architects and Marine Engineers, annual meeting, Waldorf-Astoria Hotel, New York, N. Y.

Dec. 2–5
American Institute of Chemical Engineers, annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

Dec. 2–5
American Society of Refrigerating Engineers, 47th annual meeting, Hotel Roosevelt, New Orleans, La.

Dec. 6–8
American Institute of Mining and Metallurgical Engineers, electric-furnace steel conference, Hotel William Penn, Pittsburgh, Pa.

(For ASME Calendar of Coming Events see page 955)

According to the *Engineering Journal* the Canadian engineering profession does not question the wisdom of encouraging engineers to migrate to Canada. The consensus is that Canada is a large country with a small population in great need of professional assistance. Overseas engineers were not likely to lower the level of income of Canadian engineers because these persons appreciate fully their own value in the Canadian manpower market.

Additional engineering manpower should permit Canada to transform some of its natural resources into manufactured articles rather than export these materials in a raw state. Immigration of engineers is seen as a means to develop Canadian industry and to provide additional employment for thousands of Canadians.

Canadians recognize, however, that overseas engineers may not accept the advantages of Canadian employment and that it is not likely that large numbers can be encouraged to emigrate.

People

H. G. THOMPSON, Mem. ASME, was recently appointed to the post of assistant general secretary of The Engineering Institute of Canada. Colonel Thompson is widely known in Canada through his activities in military, professional, and industrial circles. He is chairman of the Ontario Section, ASME.

* * *

ROGERS B. FINCH, Mem. ASME, assistant professor of textile technology, textile division, Massachusetts Institute of Technology, Cambridge, Mass., recently returned from a two months' visit to Japan as the textile education member of the Engineering Education Mission. The mission was sponsored by the Supreme Commander for the Allied Powers and by the American Society for Engineering Education.

Conferences and discussions were held with educators, research workers, students, and industrialists in Tokyo, Kyoto, Osaka, Nagoya, Fukuoka, Sendai, and Sapporo. Dr. Finch addressed several branches of the Textile Machinery Society, the Japan Society of Mechanical Engineers, and other engineering groups.

ASME NEWS

1951 ASME Annual Meeting Program Largest Ever

Chalfonte-Haddon Hall, Atlantic City, N. J., Nov. 26–30

WITH a record membership of more than 36,000 engineers, The American Society of Mechanical Engineers will be holding this month a record Annual Meeting of more than 90 sessions and a program of social events that should have something to contribute to every interest in the life of a professional engineer. The meeting will be held at Chalfonte-Haddon Hall, Atlantic City, N. J., Nov. 26–30, 1951.

The technical program was published on pages 854–861 of the October issue. Members are urged to review this program to remind themselves of the wealth of material to be presented. Some of the high lights of the Annual Meeting follow.

Symposiums

A feature of the technical program will be the large number of symposiums planned by various Professional Divisions and committees. These events are usually more informal, deal with timely topics, and generally are characterized by an expression of opinion or experience rather than by the formal technical treatment of a paper which has been in preparation for a long time.

In this classification are the following: Program planned by the Fluid Meters Committee on pulsation in fluid measurement; a meeting sponsored by the Education Committee and Management Division with the help of the National Junior Committee on the training of young engineering graduates in industry; the Oil and Gas Power Division's discussion on the effect of lubricating oil on Diesel-engine and gas-engine performance; the Management Division's series of programs on increasing productivity; the Production Engineering Division's two sessions, which will be virtually a clinic on production engineering; and many others. Members are urged again to study the program for these choice nuggets.

Annual Banquet

The high point of the meeting will be the banquet and honors night on Wednesday when the ASME will introduce officers for the coming year, give recognition to members who have contributed to the administration of the Society, and honor mechanical engineers who have distinguished themselves through contributions to the engineering profession.

Social Program

The President's Luncheon on Monday will inaugurate a series of social events which should bring together persons who are active in the administration and advancement of the Society. President J. Calvin Brown will be the main speaker. He will talk on the subject, "Benjamin Franklin—Statesman, Diplomat, Inventor, Author."

The Honors Luncheon on Wednesday will be the occasion for honoring recipients of engineering awards conferred jointly by several engineering societies. The recipients will be: William L. Batt, head, Economic Cooperation Administration for Great Britain, London, England, who will receive the Hoover Medal; Thomas Roy Jones, president, Daystrom, Inc., Elizabeth, N. J., who will receive the Gantt Medal; and E. G. Bailey, vice-president, The Babcock & Wilcox Company, New York, N. Y., and chairman, Bailey Meter Company, Cleveland, Ohio, who will receive the Fritz Medal.

On Thursday members will again be associating with ASME students at the annual Members and Students Luncheon. This luncheon provides the opportunity for older members of the Society to enjoy the company of aspirants to the engineering profession.

Seven other luncheons and dinners are planned by various Professional Divisions. These occasions make it possible for members of Divisions to meet with members working in their own field. The Wood Industries Division will hold its annual dinner on Monday. The speaker will be D. Morton Rose, president, D. M. Rose & Company, Knoxville, Tenn., who will speak on "Fogbound in the Dark."

Official Notice

ASME Business Meeting

THE Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday afternoon, Nov. 26, 1951, at 5:00 p.m. in the Viking Theater, 13th floor, Haddon Hall Hotel, Atlantic City, N. J., as a part of the Annual Meeting of the Society.

Members are urged to attend.

On Tuesday, the Heat Transfer Luncheon will hear E. R. G. Eckert, NACA Lewis Flight Propulsion Laboratory, Cleveland, Ohio, speak on "Problems and Progress in Aircraft Heat Transfer." The Production Engineering Luncheon will hear T. C. Geary, administrative assistant, engineering department, E. I. du Pont de Nemours and Company, talk on "Organizing Cost Reduction." The third Tuesday luncheon will be sponsored by the Fuels Division. C. E. Davis, director, refining division, Petroleum Administration, Washington, D. C., will talk on "Petroleum—Our Resources and Productivity."

The Applied Mechanics Division Dinner is planned for Tuesday at which E. U. Condon, director of research, Corning Glass Company, Corning, N. Y., will be the main speaker. His topic will be "Some Thoughts on Scientific Research in Federal Government." The Hydraulic Division will also hold its Hydraulic Old Timers Dinner on Tuesday.

The last luncheon on the program will be on Friday when the Textile Division will meet to hear Joseph M. Leahy, director of research, Volkart Brothers, Inc., New York, N. Y., who will talk on "The 1951 Cotton Crop."

Science Theater

One of the high lights of the Annual Meeting will be a program of industrial films assembled by W. F. Coles, Jr., chairman of the Science Theater Committee, for showing in the excellent theater available at the headquarters hotel. The films, many of which are in color, will illustrate industrial processes, designs of new equipment, and many engineering problems. Some 44 films are included in the program. Running from 11 to 45 minutes each, they will conserve hours of time and effort for viewers who prefer armchair comfort to the fatiguing bus trips of a tour. Some of the films will be: "Crude Oil Distillation," by Shell Oil Company; "Alloy Steels," by the U. S. Bureau of Mines; "Development of Steam," by The Babcock & Wilcox Company; "Jet Propulsion," by the General Electric Company; and others.

Roy V. Wright Lecture

W. C. Mullendore, president, Southern California Edison Company, Los Angeles, Calif., will be the 1951 Annual Meeting Roy

Registration Schedule

Sun., Nov. 25	2:00 p.m. to 5:00 p.m.
Mon., Nov. 26	8:00 a.m. to 8:00 p.m.
Tues., Nov. 27	8:00 a.m. to 8:00 p.m.
Wed., Nov. 28	8:00 a.m. to 7:00 p.m.
Thurs., Nov. 29	8:00 a.m. to 8:00 p.m.
Fri., Nov. 30	8:00 a.m. to 3:00 p.m.

Fees for Nonmembers

A registration fee of $5 will be charged nonmembers attending the 1951 Annual Meeting of The American Society of Mechanical Engineers. The fee for student nonmembers will be $1.

The following nonmembers will be exempt from the payment of the registration fee

- Immediate family of a member (any grade)
- Authors listed in the program or their appointed representatives
- Invited discussers
- Session chairmen and vice-chairmen
- Committeemen required to attend a meeting of their committee
- Session aides
- Members of the ASME Woman's Auxiliary
- Members of The Engineering Institute of Canada
- Members of societies listed in the program
- Distinguished guests invited by the President or Secretary.

V. Wright Lecturer. The lecture, which honors the late Dr. Wright, president of the Society in 1931, will be delivered on Tuesday at 5 p.m. Mr. Mullendore will speak on "The American Retreat From Freedom."

Junior Conference

The National Junior Committee will sponsor a conference on Monday evening at which Martin D. Whitaker, president, Lehigh University, Bethlehem, Pa., will speak on "A Current Plan for Young Engineers." The conference will wind up a series of four meetings in various parts of the country at which delegates from local Sections of the Society discussed various aspects of professional development. The conference should be of interest because it will mark the anniversary of the conception of the National Junior Committee at Atlantic City in 1947. The committee has succeeded in broadening the opportunities for young engineers in the work of the Society.

American Rocket Society

The American Rocket Society, which is an affiliate of the ASME, is rapidly gaining recognition as the leading American technical group in the rocket industry. The ARS is planning five technical sessions for the 1951 Annual Meeting beginning Wednesday afternoon running through Friday afternoon. In addition to committee meetings, the program includes the annual Honors Dinner, scheduled for Thursday, at which men who have made contributions to rocket development will be honored.

College Reunions

The ASME Annual Meeting is traditionally the time for college reunions because so many engineers from widely separated cities attend the technical sessions. To date the following schools have announced their intention to hold reunions: University of California, Cornell University, University of Michigan, Stevens Institute, Northeastern University, and Purdue University. Alumni are urged to inquire at the registration desk for further information about the time and place of these reunions.

Ladies Program

An interesting program has been planned by the Philadelphia section of the Woman's Auxiliary. The program follows:

Sunday: Nov. 25, 4:00–6:00 p.m., informal tea, Vernon Room; 7:45 p.m., hotel concert, lounge of Chalfonte.

Monday: Nov. 26, 12:00 noon, President's Luncheon, Carolina Room; 3:00 p.m., illustrated lecture, "Bird Life," by Mrs. Warner Seely, Viking Room; 5:30–7:00 p.m., reunion and social hour, West Room; 9:00 p.m., bridge party, Vernon Room.

Tuesday: Nov. 27, 10:15 a.m., coffee hour and auxiliary skit, Vernon Room; 4:30–6:30 p.m., tea dance, Vernon Room; 9:30 p.m., Monte Carlo party, Caroline Room.

Wednesday: Nov. 28, 10:30 a.m., annual business meeting; 12:30 p.m., annual luncheon, Dramatic Piano Portraits, by Florence Fraser Ludgate, West Room; 7:00 p.m., Annual Dinner and Honors Night.

Thursday: Nov. 29, 11:00 a.m., inspection tour of Chalfonte-Haddon Hall kitchens.

Heat-Transfer Discussions

THE Heat Transfer Division of The American Society of Mechanical Engineers will devote two of its seven technical sessions at the 1951 ASME Annual Meeting to a continuation of the heat-transfer discussions held in London, Sept. 11–13, 1951.

The London discussions covered 80 papers by authors residing in the U. S., Britain, the British Commonwealth, and western Europe. The papers are under five sections: (1) Heat transfer with change of state; (2) heat transfer between fluids and surfaces; (3) conduction in solids and fluids; (4) radiation, instrumentation, measurement techniques, and analogies; and (5) special problems. For a list of American papers, see page 602 of the July issue of MECHANICAL ENGINEERING.

Copies of papers are available at the offices of the ASME in New York. Persons interested in discussing any particular paper may receive a copy free on request. A complete set of papers may be purchased for $8.

All discussions should be submitted in writing on or before the sessions at Atlantic City. These will be incorporated in the proceedings of the London meeting and will become part of the official record of that event.

New ASME Officers Elected by Letter Ballot

AS reported by the tellers of election, 1952 officers, E. H. Barlow, John Haydock, and C. W. Obert, letter ballots received from members of The American Society of Mechanical Engineers, were counted on Sept. 25, 1951. The total number of ballots cast was 10,912; of these 436 were thrown out as defective.

	Votes for	*Votes against*
For President		
R. J. S. Pigott	10462	14
For Regional Vice-Presidents —serve two years		
Willis F. Thompson	10461	15
Ernest H. Hanhart	10461	15
Ernest S. Theiss	10466	10
Samuel H. Graf	10469	7
For Directors at Large— serve 4 years		
Albert C. Pasini	10464	12
Paul B. Eaton	10462	14

The new officers will be introduced and installed in office during the 1951 Annual Meeting of the Society to be held at the Chalfonte-Haddon Hall, Atlantic City, N. J., Nov. 26–30, 1951.

Biographical sketches of the newly elected officers were published in the August, 1951, issue of MECHANICAL ENGINEERING, pages 686–689.

Industrial Minneapolis Scene of Successful 1951 Fall Meeting

AS ONE of the largest industrial centers of the Midwest, Minneapolis, Minn., site of this year's ASME Fall Meeting, held Sept. 26–28, 1951, offered a great deal of interest to the more than 550 mechanical engineers in attendance. Featured was the technical program consisting of 23 sessions during which 47 papers were delivered. In addition, the program included the Calvin W. Rice and Roy V. Wright Lectures, a Junior Conference, two luncheons, a banquet, five inspection trips, and an interesting program for the ladies.

Technical Sessions

Recent developments and new trends in mechanical engineering highlighted the technical program. For example, papers covered recent advances in industrial process steam turbines, current research on lignite, operation of large boilers with lignite, coal handling and storage of coal, boiler-feedwater treatment, radial turbomachines, magnesium-treated nodular cast iron, tooling of an automatic transmission, determination of dust concentration on flour-mill suction systems,

lubrication of flour milling machinery, and on industrial research in general.

Other fields covered included management, heat transfer, industrial instruments, safety, and machine design. In addition, a round-table discussion on the postgraduate training of engineers in industry was held in co-operation with the Minnesota Society for Professional Engineers, and a joint session on engineering and design of farm machinery was cosponsored by the American Society of Agricultural Engineers. A session sponsored by the American Rocket Society, an affiliate of ASME, included discussion of rocket fuels.

Digests of available 1951 ASME Fall Meeting papers appear on pages 929–934 of the ASME Technical Digest section in this issue. Digests of remaining papers will be published in forthcoming issues of MECHANICAL ENGINEERING and some of the papers will be published in full in MECHANICAL ENGINEERING and ASME Transactions.

President's Luncheon

ASME members and guests were given a hearty welcome to Minneapolis at the President's Luncheon, on Wednesday, September 26, the first social event of the Fall Meeting. W. Lyle Borst, chairman of the local meeting committee, welcomed the group in behalf of the Minnesota Section, while the Honorable Erik Hoyer, mayor of Minneapolis, extended the city's greetings.

J. Calvin Brown, president of ASME, who presided over the meeting, read a letter from Ed. A. Uehling, of West Allis, Wis., who is 102 years old and ASME's oldest living member. Mr. Uehling said he had intended to be present at the meeting but regretted that a slight illness had prevented his doing so. He sent his best wishes to the Society and all its members for a successful meeting.

The principal speaker on the program was Warren Courtland MacFarlane, president and general manager of Minneapolis Moline Power Implement Company. He spoke informally and reminisced about his early days in the field of engineering.

Calvin W. Wright Lecture

Dr. F. Oederlin, managing director in charge of engineering, Sulzer Brothers, Ltd., Winterthur, Switzerland, on Wednesday afternoon delivered this year's Calvin W. Rice Lecture. This lecture was named to honor the man who served as secretary of the Society from 1906 to 1934 and to further the two ideals he had fostered, namely, to increase understanding between the engineers of various countries, and to stimulate the programs of meetings outside of the Annual Meeting in New York, N. Y. Dr. Oederlin's topic was "Engineering Achievements in Switzerland and Their Background."

F. OEDERLIN RELAXES AFTER DELIVERING CALVIN W. RICE LECTURE ON ENGINEERING ACHIEVEMENTS IN SWITZERLAND

LAUNCHING THE 1951 ASME FALL MEETING, W. LYLE BORST WELCOMES MEMBERS TO MINNEAPOLIS IN BEHALF OF THE MINNESOTA SECTION AT THE PRESIDENT'S LUNCHEON

Roy V. Wright Lecture

The Wright Lecture, established in 1949 in honor of Roy V. Wright, president of the Society in 1931, as a tribute to his contributions as a citizen to the nation and his community, was delivered by John W. Barriger, 3rd, Mem. ASME, president, Chicago, Indianapolis, and Louisville Railway, Chicago, Ill. Featured on Thursday's luncheon program, Mr. Barriger spoke on "Engineering, the American Heritage." J. Calvin Brown, president ASME, presided at the luncheon, and James Lewis Morrill, president, University of Minnesota, introduced the speaker.

J. Calvin Brown Addresses Banquet

The banquet, which was the main social affair of the Fall Meeting, was held on Thursday evening. President Brown, the principal speaker, addressed the gathering on the subject, "The Engineer and the American Way of Life." His talk will appear in MECHANICAL ENGINEERING at a later date. James A. Colvin, Mem. ASME, of the Northern States Power Company, served as the toastmaster.

Inspection Trips

An excellent opportunity to visit a number of industrial plants was offered to engineers during their stay in Minneapolis. On Wednesday a group visited Brown and Bigelow in St. Paul, where they saw the color-offset method in operation, printing calendars, playing cards, and picture advertising. Two trips were scheduled for Thursday afternoon. One was to the Minneapolis Moline Company, where the visitors saw the manufacture of farm machinery such as tractors and hay balers, and industrial power units; the other was to General Mills, Inc., which offered a visit through one of the foremost milling centers in the country. Production of flour and cereal and also the manufacture of precision machinery were inspected. The University of Minnesota Hydraulics Laboratory, located at historic St. Anthony Falls on the Mississippi River, was toured on Friday morning. Actual river flow facilitates scale modeling of hydraulic projects. In the afternoon, at the Minneapolis-Honeywell Regulator Company, a group saw the manufacture of a multitude of instruments for use in heating, ventilating, air conditioning, aeronautics, and research.

ASME PRESIDENT J. CALVIN BROWN ADDRESSES ROY V. WRIGHT LUNCHEON

Women's Program

A full program was planned to entertain the women visitors present at the meeting. On Wednesday morning they took a sight-seeing tour of the twin cities, including State University, Twin City parks and lakes, and Minnehaha Falls. Luncheon was served at Sibley House, followed by an inspection trip through Brown and Bigelow in the afternoon. In the evening a bridge party was held at the hotel. Thursday's program included a tour of Dayton's—Minneapolis department store—through some of the specialty shops, gallery, and kitchen, ending with a luncheon in Dayton's Sky Room and a fashion show.

Committees

The committees of the Minnesota Section, whose planning and hard work insured the success of the meeting, were as follows: *General*, W. Lyle Borst, chairman; Daniel J. Greenwald, vice-chairman; *technical events*, E. N. Kemler, chairman; *plant trips*, Milton S. Wunderlich, chairman; Adolph O. Lee, alternate; *entertainment*, Raymond T. Lesch, chairman; Robert L. Thomas; *publicity*, James A. Colvin, chairman; *hotels*, P. D. Robinson, chairman; R. T. Gadbois, John K. Moorhead, E. J. Holzer, and J. J. Ryan; *information and registration*, Howard Chatfield, chairman; Dean B. Chenoweth, John G. Davies, Asbjorn M. Severson; *reception*, Frank B. Rowley, chairman; Carl A. Herrick, B. J. Robertson, Knox A. Powell, Lorenz G. Straub, and Lee M. Whitson; *finance*, Homer L. Rank, chairman; Ed. S. Howard; *signs*, Francis J. Green, chairman; Robert W. Ernt; *ladies' events*, Mrs. Daniel J. Greenwald, chairman; Mrs. W. Lyle Borst, Mrs. Robert L. Thomas, Mrs. Adolph O. Lee, and Mrs. Lee S. Whitson.

Petroleum Division Holds Record Conference in Tulsa, Okla.

W. G. Heltzel and E. W. Jacobson Honored

THE SIXTH annual conference of the Petroleum Division of The American Society of Mechanical Engineers was held at the Mayo Hotel, Tulsa, Okla., Sept. 24-26, 1951. The three-day meeting, featuring 16 sessions and 40 technical papers covering the fields of oil production, transportation, and refining, attracted more than 400 engineers from all sections of the United States and proved to be the most successful conference in the recent history of the Division.

The conference opened with three sessions Monday morning, Sept. 24, on the subjects of pilot-plant design, production pumping problems, and pipe-line metering. Six sessions were held Tuesday, Sept. 25, dealing with drilling problems, welding, corrosion, pipe-line engines, offshore drilling structures, and plant instrumentation. On Wednesday, Sept. 26, the last day of the meeting, four technical sessions were held on such subjects as equipment selection problems, design conclusions, materials, pump problems, and pipe-line control problems. All sessions were well attended and discussion was lively and informative.

President Brown Speaks

On Monday, Sept. 24, in conjunction with the Tulsa Engineers' Club, a welcoming luncheon was held for the registrants and their guests. The audience of 200 heard the Honorable George E. Stoner, Mayor of Tulsa, welcome the Division and present a key to the city to President J. Calvin Brown.

President Brown gave the principal address. He reviewed the early history of petroleum in the United States, pointing out that our country had contributed two thirds of the oil used by the world in the last 60 years. He also indicated the possibility of the earth's oil reserves being inexhaustible because of the energy transmitted to the earth from the solar system.

"There is some doubt," President Brown said, "whether or not we will exhaust all our oil supply because if this energy sent to the earth from the sun is actually stored in the earth, then oil will be continuously formed by the process of transformation."

Petroleum Conference Digests

Digests of 11 of the papers presented at this meeting appear in the "ASME Technical Digest" on pages 924 to 929 of this issue. Digests of any remaining preprinted conference papers will be published in a forthcoming issue of MECHANICAL ENGINEERING.

Inspection Tours Enjoyed

Following the luncheon, the members and guests left the hotel by bus for Bartlesville to inspect the new Phillips Petroleum Company's research and automotive laboratories. A feature of this modern building was the many facilities provided for employee relaxation and recreation. These included a gymnasium with basketball court able to seat 5000 people, a regulation-size tournament swimming pool, several bowling alleys, a women's club, a men's club, a cafeteria for 1000 people, and several snack bars.

After the tour of the laboratories, visitors took buses to Frank Phillips' Woolaroc Ranch 14 miles southwest of Tulsa. Here they toured the Woolaroc Museum which depicts the history of America, with particular emphasis on the Southwest.

R. K. Lane, president, Public Service Company of Oklahoma, was toastmaster at the annual banquet which was held on Tuesday. H. H. Anderson, vice-president and general manager, Shell Pipe Line Company, Houston, Texas, was the main speaker. His subject was "Conservation of Manpower and Materials."

Mr. Anderson urged engineers to "compromise with perfection" to meet the nation's growing demands on the petroleum industry. He pointed out that "the expedient use of available components is a must for conservation during our emergency." He also warned against engineering students overspecializing and called on engineering schools to "give us more engineers who can transcend the technical job of appraising needs and making layouts."

GREETING PRESIDENT BROWN UPON ARRIVAL AT TULSA

(*Left to right:* J. M. Sexton, chairman, Petroleum Division; R. G. Critz, chairman, Mid-Continent Section; O. L. Lewis, chairman, Petroleum Division Refining Committee; J. Calvin Brown, ASME president; B. B. Morton, secretary, Petroleum Division; and F. J. Daasch, chairman, Tulsa arrangements.)

Heltzel and Jacobson Honored

As part of the banquet ceremonies, F. J. Daasch, chairman, Local Arrangements Committee, presented a Fellow-grade membership certificate to William G. Heltzel of Tulsa. Mr. Heltzel is a graduate of Carnegie Institute of Technology.

Another feature of the banquet was a brief talk by J. M. Sexton, chairman, ASME Petroleum Division, who spoke on the activities of the Petroleum Division and urged the continued support of mechanical engineers in oil companies, pipe-line companies, and service companies. Mr. Sexton concluded with a presentation to E. W. Jacobson, chief design engineer, Gulf Research and Development Company, Pittsburgh, Pa., of a testimonial of regard and appreciation by his associates in the Petroleum Division for his efforts in furthering the advancement of mechanical engineering in

ASME Calendar of Coming Events

Nov. 26-30
ASME Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.
(*Final date for submitting papers was July 1, 1951*)

March 24-26, 1952
ASME Spring Meeting, University of Washington, Seattle, Wash.
(*Final date for submitting papers—Nov. 1, 1951*)

June 15-19, 1952
ASME Semi-Annual Meeting, Sheraton Gibson Hotel, Cincinnati, Ohio
(*Final date for submitting papers—Feb. 1, 1952*)

June 19-21, 1952
ASME Applied Mechanics Division Conference, The Pennsylvania State College, State College, Pa.
(*Final date for submitting papers—Feb. 1, 1952*)

June 23-27, 1952
ASME Oil and Gas Power Division Conference, Hotel Statler, Buffalo, N. Y.
(*Final date for submitting papers—Feb. 1, 1952*)

Sept. 8-11, 1952
ASME Fall Meeting, Sheraton Hotel, Chicago, Ill.
(*Final date for submitting papers—May 1, 1952*)

Sept. 8-12, 1952
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Cleveland, Ohio
(*Final date for submitting papers—May 1, 1952*)

Sept. 22-24, 1952
ASME Petroleum Mechanical Engineering Conference, Hotel President, Kansas City, Mo.
(*Final date for submitting papers—May 1, 1952*)

Nov. 30-Dec. 5, 1952
ASME Annual Meeting, Statler Hotel, New York, N. Y.
(*Final date for submitting papers—July 1, 1952*)
(*For Meetings of Other Societies see page 951*)

the petroleum industry. Mr. Jacobson, past-chairman of the Division, was instrumental in its reorganizational activities.

Two brief addresses on the engineering profession were also given by L. L. Dresser, president, National Society of Professional Engineers, and F. G. Fellows, president, Oklahoma State Society of Professional Engineers, who were in attendance as honored guests.

On Wednesday, besides seven technical sessions, special events were held for the benefit of the ladies in attendance at the conference, consisting of a tour of Tulsa, a visit to the Philbrook Art Center, lunch at the Tulsa Country Club, and an afternoon visit to the Thomas Gilcrease Museum of Indian life and culture. This affair was well attended. The activities concluded with an inspection trip to the Mid-Continent Petroleum Corporation, West Tulsa refinery.

Reported by J. M. SEXTON.

Instruments Conference Held at Houston, Texas

MORE than 200 members and guests attended the 1951 National Conference of the Industrial Instruments and Regulators Division of The American Society of Mechanical Engineers held in Houston, Texas, Sept. 10–14, 1951. The conference was a part of the Sixth National Instrument Conference and Exhibit sponsored by the Instrument Society of America.

The ASME part of the program consisted of two technical sessions, a luncheon, and a panel discussion on the relation of cybernetics to industrial control.

Everett S. Lee, Luncheon Speaker

The high light of the social program was a luncheon at which Everett S. Lee, editor, *General Electric Review*, General Electric Company, Schenectady, N. Y., spoke on "A Threat to Our Technical Leadership." According to Mr. Lee, the current shortage of engineers poses a threat to the technical leadership of the United States. "This is the time," he urged, "for all good engineers and scientists to come to the aid of their country by going the 'second mile' beyond their present important work in the defense program to bring to young men in the high schools who are fitted for engineering and science, the counsel to work hard in their courses, to master them, and to keep continually on in their endeavor to finish their engineering and scientific education against all odds."

The Technical Program

The technical sessions were devoted to latest developments in aviation and geophysical instruments. The Monday morning sessions began with a paper describing a new multiresponse totalizing system which combines a variable orifice flowmeter with differential synchros and a novel servo system. The second aviation paper presented a method for analysis and synthesis of the aircraft lateral-control problem.

Three papers were presented on geophysical instruments. The first was a review of instrumentation for instruments for exploration geophysics particularly as applied to petroleum exploration. The seismic, gravimetric, and magnetometric methods were discussed with emphasis on application in other fields of engineering. In another paper the Schmidt type field magnetometer was described. Of particular interest also was a paper on a new precision barometer and barograph of sufficient accuracy for use in elevation measurements such as are associated with modern gravity surveys.

The application of servomechanisms to industrial processes was taken up in a panel discussion by Rufus Oldenburger, Woodward Governor Company, Rockford, Ill., E. L. Harder, Westinghouse Electric Company, Pittsburgh, Pa., O. Hugo Schuck, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn., and C. E. Mason, Bristol Company, Waterbury, Conn.

ASME Standards Workshop

Gears

SEVERAL years ago the Sectional Committee B6 on Gears undertook a study of four standards promulgated by the American Gear Manufacturers Association covering fine-pitch gear systems. The result of this work was a series of American standards currently finding wide acceptance in industry.

On Oct. 31, 1951, Sectional Committee B6 is meeting in Chicago, Ill., to plan for a critical review of other standards of the American Gear Manufacturers Association with the idea of recommending some for adoption as American standards. Alexander W. Luce, head, department of mechanical engineering, Pratt Institute, Brooklyn, N. Y., is chairman of Sectional Committee B6.

V-Belts

SECTIONAL Committee B55 on V-Belts and V-Belt Drives met in the Engineering Societies Building, New York, N. Y., Oct. 16, 1951, to consider adoption as an American standard the standard on Multiple V-Belt Drives published by the Multiple V-Belt Drives and Mechanical Power Transmission Association and The Rubber Manufacturers Association.

A Subcommittee headed by Roger Boltz, assistant editor, *Machine Design*, Penton Publishing Company, Cleveland, Ohio, as chairman, was appointed to undertake critical review of the proposed document. Colin Carmichael, editor, *Machine Design*, is chairman of Sectional Committee B55.

Graphic Presentations

SECTIONAL Committee Z15 on Graphic Presentations met in New York, N. Y., on October 19, 1951, to consider a draft of a proposed standard which combines American Standard Engineering Slides and Charts for Lantern Slides, Z15.1-1934, and Engineering and Scientific Graphs for Publication, Z15.3-1943.

It is expected that the proposed standard will eliminate difficulties encountered by authors who must prepare illustrations for publication by one standard and illustrations for use in preparing lantern slides by a different standard.

Douglas P. Adams, professor, mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass., presided.

Flow Measurement

DELEGATES from 15 countries participated in the second meeting of the Technical Committee on Measurement of Fluid Flow of the International Organization of Standardization held at the Centre Marcelin-Berthelot, Paris, France, Oct. 10–13, 1951.

Purpose of the meeting was to continue discussions begun at the first meeting of the committee in 1948 and to draft a proposed standard by co-ordinating the national standards of participating countries.

The American delegation was headed by Andre L. Jorissen, head, department of hydraulics and hydraulic engineering, school of civil engineering, Cornell University, Ithaca, N. Y.

Dr. Jorissen is a member of the subcommittee on International Standards of Flow Measurement of the Fluid Meters Research Committee of The American Society of Mechanical Engineers.

Fred Kuehn, associated with the Foxboro Company, Foxboro, Mass.; F. O. Spitzer, associated with the Rockwell Manufacturing Company, Pittsburgh, Pa.; and P. J. Sullivan, associated with the Brown Instruments Division, Minneapolis-Honeywell Regulator Company, Philadelphia, Pa., were also members of the American delegation serving in an advisory capacity.

Among the subjects discussed were: Coefficients for Venturi tubes with standardized nozzles, correlation between the velocity profile and coefficients designated in the proposed standard, results of experiments on classical-type Venturi tubes, practice and gaging methods of vanes, results of experiments on the measures for small Reynolds numbers, and others.

The Paris meeting was part of the long-range standardization program inaugurated by the former International Standards Association at a meeting in Paris in 1928. Measurement of fluid flow through nozzles and orifices was the subject of international discussions at meetings held in Milan (1932), Stockholm (1934), Helsinki (1939), and Paris (1948).

The International Standards Association was reorganized in 1948 as the International Organization for Standardization. The project for standardization of measurement of fluid flow was reactivated and the Association Francaise de Normalisation continued to serve as secretariat.

Junior Forum

The Pro and Con of Working in an Isolated Community

By Clarence R. Adams[1]

AS A recent graduate who has spent the first year of his career in a remote mining community far from engineering-society activity, an account of my experience may be useful or of interest to other young engineers who may be considering the pros and cons of similar employment.

My experience has been in Garrison, N. D. There are a limited number of mechanical engineers in North Dakota. Less than 10 mechanical engineers are registered in the state and they are mostly university professors. Approximately 94 per cent of those registered are engaged in civil engineering. Of the 169 residents of this state who are registered professional engineers, 60 per cent are employees of cities, counties, state, and federal agencies. The professional registration roster does not include the majority of engineers in the state but it is a good indication of the distribution of engineers.

My company operates four strip coal mines in North Dakota with a total production of about 1.8 million tons of lignite per year. Five engineers are employed in the company's operations. The general superintendent, who has charge of mining operations at all four mines, is a mechanical engineer. One mining engineer and one civil engineer are employed in addition to the service and sales engineer and myself who are mechanicals.

The company does not have an engineer-in-training program. I had worked, however, as a shop mechanic at one of the mines during summer vacation and the following summer as a tipple laborer at another mine. My experience as a shop mechanic has been especially helpful in my present position as I became familiar with company shop practices, equipment, and personnel.

Wide Range of Responsibility

After receiving my BS degree from Purdue University, I returned to the company as an engineer. Soon I realized that an engineer with the company was expected to handle all phases of engineering necessary in the operation of a coal mine and not just the mechanical phases. This includes: planning new construction; supervising erection of new structures; installing new equipment; determining the methods and equipment necessary for improved coal preparation; deciding what equipment should be standardized and interchangeable; surveying for roads and ditches; and making maps of the mining progress.

This sounds like a lot of work but it is spread out over a year's time. The mapping and surveying only take about a week's time per mine unless there is exploration work being done with the aid of a drill rig. During the winter months most of the engineers' time is spent drawing plans for new equipment or changes in the coal-preparation plant. As industrial coal is usually loaded only about three days per week during the summer and orders for domestic sizes usually drop to almost zero during that period, the summer months are the best time of the year to make changes in equipment.

The First Project

My first project with the company was to plan the installation of a 200-ton per hour hammermill crusher to the tipple equipment. The object of this addition was to improve the sizing of our stoker and industrial coal. A number of interesting problems came up before this project was completed. Plans of the existing structure were very much incomplete and consisted of pencil drawings to the scale of $\frac{1}{4}$ in. to the foot. As few dimensions were given, it was necessary to do a lot of measuring before an accurate drawing with dimensions could be made so that the plans for the addition would match the existing structure.

At this time I instituted a numbering plan for the drawings and a standard title block. The numbers consist of: first, a letter which indicates the mine the drawing is applicable to; second, two digits which indicate the year; and third, one or more digits indicating the actual drawings numbered for that particular mine that year. These are numbers recorded in a drawing index.

Constructing the new addition required the pouring of four additional concrete footings. After the forms were set, I checked their center lines and elevations to be sure they were correct. I failed to realize at the time, however, just how much lift concrete will have on a truncated pyramid type of footing form when poured rapidly. The first two forms poured did not move but the third one raised slightly when the operator of the ready-mix truck let the load go all at once. I was able to repair the damage by cutting about an inch from the top of the footing form. The use of a surveyor's level made rechecking the footing elevation accurate and simple. Center lines were rechecked and found to be correct. This experience taught me the importance of taking sufficient precautions when setting forms for use with ready-mix concrete.

During the winter months while working up the plans, I observed that there was considerable difficulty in opening slide-type gates on flight conveyers because of the accumulation of frozen coal slack. For the new drag conveyer I designed a hinged gate which opens down. This gate has been easy to operate in winter and summer. As the tipple is unheated, the equipment must be designed to operate in temperatures down to —40 F.

Pros and Cons of Isolation

Perhaps the biggest advantage in a position such as this is the opportunity to work on a project from the time of its conception until it is installed and operating. If mistakes in design show up during operation, the engineer has a firsthand opportunity to discover the cause of failure as well as limitations which become apparent only in operations over a considerable period of time.

A second advantage is the opportunity to handle men and learn what some of their shortcomings are so that new equipment can be designed which will function properly with semiskilled operators.

The disadvantages I have encountered include the lack of an opportunity to continue one's education except for the practical experience gained and the technical reading one can do. Another distinct disadvantage is the lack of professional fellowship and mutual aid which I assume to be available where engineering societies are active.

Still another disadvantage is the lack of

[1] Jun. Mem., Truax-Tracer Coal Company, Garrison, N. D. Mr. Adams was a member of last season's Junior Panel of 200 who were asked to comment on the Society's program for junior engineers.

AT THE JUNIOR CONFERENCE (*left to right*) D. J. GREENWALD, JR., FRED T. AGTHE, AND DEAN B. CHENOWETH, COMPARE NOTES BEFORE JUNIOR MEETING GETS UNDER WAY

equipment distributors in the immediate locality. This necessitates ordering most specialized equipment sight unseen. Trade magazines, engineering magazines, and especially the ASME Mechanical Catalog and Directory, have been a great help in locating distributors of needed equipment.

For an engineer who wishes eventually to get into management, I believe a position as an engineer in an isolated community is excellent training. It is rather limited for the engineer who is interested in doing research. It requires more practical application than theoretical and will have a greater coverage of engineering fields, but this coverage will be less thorough.

Professional Development Should Be First Aim of Young Engineers

A YOUNG engineer should devote his leisure time to systematic professional development, Fred T. Agthe, process engineer, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., told the Junior Conference, held during the ASME Fall Meeting in Minneapolis, Minn.

Mr. Agthe spoke on "A Current Plan for Young Engineers." He stressed the fact that reading and contact with informed individuals within and without the profession and a continuous study of developments in the fields of energy, materials, processes, and products, were more important during the early years of an engineer's career than "community interests."

"After the young engineer has established himself and is recognized as an engineer of attainment, only then should he begin to devote some of the time at his disposal to enter a larger field of community activities that is useful, constructive, and compatible with his background and mental development.

"It is believed that premature entrance into civic activities with too much fanfare and blatancy will detract from the engineer's professional status and will consume too much time that should be employed in other important and useful channels", Mr. Agthe said.

The Minneapolis conference was the third of four planned for 1951 under the general theme "A Current Plan for Young Engineers." Attending the conference as official delegates from the ASME Sections in Region VI were: *Nebraska*, L. J. Berkheimer; *Central Iowa*, R. H. Burgan; *Rock River Valley*, J. G. Floden, *Chicago*, John J. Noble; *Iowa-Illinois*, Newton N. Sacks; *Central Illinois*, C. L. Sonnenschein; *Milwaukee*, Raymond J. Sullivan; and *Fort Wayne*, J. C. Willsey.

During the discussion which followed Mr. Agthe's talk, interest centered on engineering education. One speaker pointed out the importance to young engineers of realizing the difference between problems assigned in the classroom and those encountered in industry. Another speaker pointed out the advantage of co-operative education during which a student splits his time between college and industry. The point was also made that college time could be saved by raising entrance standards.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

Men Available[1]

Executive Mechanical Engineer, N. Y. and Pa. license, broad experience, including: raw sugar; power, both utility and industrial; research laboratory; fertilizer plants, and phosphate furnaces. Considerable experience with consulting concerns. Me-853.

Management Engineer, 34, BSME, registered. Three and a half years' maintenance engineer in an alkali-chemicals plant, two years as chief engineer in a steel-fabricating company (miscellaneous iron), and five years in testing, warehousing, and supervisory work. Desires sales, consultant, or supervisory work. Small organization preferred. Me-854.

Mechanical-Industrial Engineer, 31, BSE, ten years' administrative and technical engineering and manufacturing functions in process and metalworking industries. Development, co-ordination, design, estimating, handbooks, specifications, reports, calculations, plant layout and engineering, tooling, methods, etc. Desires staff-level position. Me-855.

Chief Engineer, 50, executive, mechanical engineer, experienced in directing product design and development, methods, plant layout, time study, and consultant engineering. Specialized in low-cost product design and production methods. Me-856.

Mechanical Engineer, 34, BSME, MS. Ten years' experience in development and design of mechanical equipment and processes. Five years in supervisory capacity. Desires association with progressive company in position leading to chief engineer. Now employed. Me-857.

Mechanical Engineer, 37, BS, with 16 years' experience in design, research, development of aircraft and rocket engines, including administration and production liaison. Special background in compressors, turbines, combustion, heat transfer, and supersonic flow. Me-858.

Positions Available

Director of Research, mechanical or chemical graduate, to take complete charge of setting up a research and development department, particularly as to processes and machinery (no basic research) in the process industry. $8000–$12,000. Midwest. Y-6008.

Engineers. (*a*) Project engineers for machine-design research, mechanical graduates, at least ten years' board experience, including a substantial amount of time on machine design incorporating a multiplicity of motions such as levers, cams, eccentrics, genevas, etc. Should be able to create a design plan for machine, equipment, or process including direction of research work, engineering work, and experimental testing work. $6000–$10,000, depending on experience. (*b*) Machine-design chief, mechanical graduate, at least ten years' board experience, including a substantial amount of time on machine design. Must be able to create a machine design, analyze thoroughly the functional operations, determine material requirements, prepare jury rigs for testing operations, supervising layouts, etc. $8000–$10,000, or higher. (*c*) Chief production engineer, mechanical graduate, at least ten years' board experience and a substantial amount of time working on the development of machinery for production. Must be familiar with automatic machinery. Should have tooling experience and ability to analyze operating problems on machinery in production. Experience in the development of machinery for efficient production and operation desirable. $8000–$10,000, or higher. Pa. Y-6012.

Design Engineer, mechanical graduate, ten years process-plant design and field experience, to design and lay out power and process equipment. $6760. New York, N. Y. Y-6032.

Plant Engineer for work including responsibility and supervision of all maintenance, engineering, and power-plant activities. $6000. Mass. Y-6038.

Engineers. (*a*) Instrumentation engineer, mechanical or chemical graduate, preferably two to four years' experience in chemical-process industry. (*b*) Safety engineer, mechanical or chemical graduate, one or two years' experience in making safety studies in chemical plant. (*c*) Process engineer, chemical or mechanical graduate, two to four years' experience in process design, layout, etc., for large chemical plant. (*d*) Power-plant engineer, five to ten years' experience in industrial steam-power generation and public-utility power-plant operation. Will do some design, specification writing, etc. Salary open. Philadelphia, Pa. Y-6030.

Senior Production Engineer, over 30, mechanical graduate, at least five years' experience covering manufacturing procedures, machine-shop practices, inspection, and test methods of materials, establishment of tolerances and allowances, redesign for production of small mechanisms in office-machine or allied fields. $5600–$6900. Conn. Y-6072.

Mechanical or Aeronautical Engineer, graduate, several years' experience in engineering design, computation, and testing required. Will supervise small engineering staff of research organization. Activity will be in a broad field, including control and servomechanisms, hydrodynamics, and mechanical design. $7500–$10,000. Md. Y-6078.

Junior Mechanical Engineer, graduate, three to four years' experience, preferably in business administration or purchasing. Will be trained for six months to one year in the purchasing department of a large manufacturer. $4800–$5400. New York, N. Y. Y-6096.

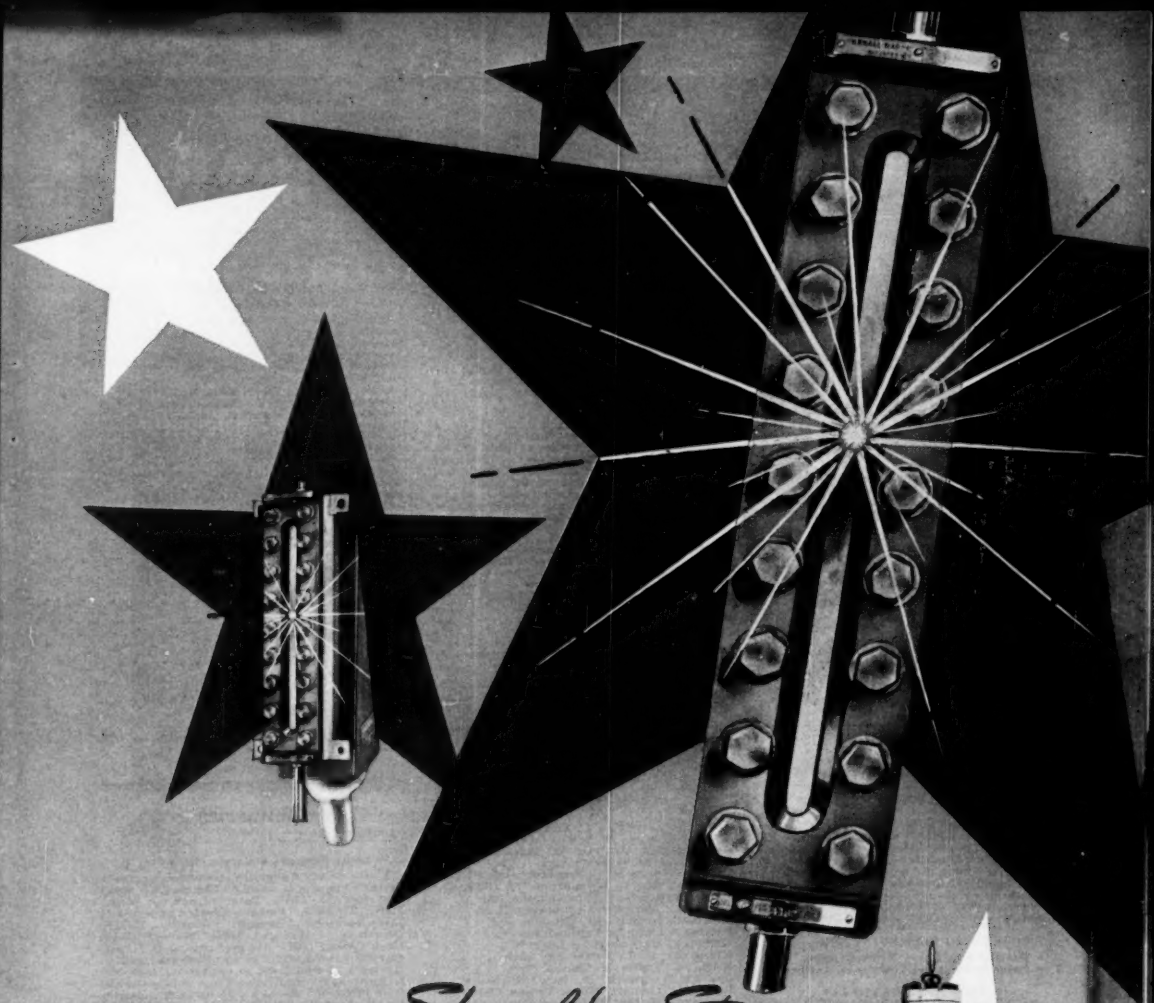
Design and Development Engineer on gas heating equipment, mechanical graduate. Specific experience in the design and manufacture of gas heating products would be highly desirable but not absolutely essential if experienced in sheet-metal products. Must be capable of making original design layouts and of following the design project through all phases of engineering including technical analyses, laboratory and field testing, design for American Gas Association approval, co-operation with production engineering in tooling and cost studies, advise and assist manufacturing division in early production phases, etc. $6000–$8000. Ill. Y-6097.

Junior Mechanical or Industrial Engineer, 26–30, methods and planning experience covering materials handling, warehousing, in commercial fields, to assist in preparation of cost data, layout improvements, etc. $4200–$4800. New York, N. Y. Y-6102.

Chief Design Engineer, 38–45, to take charge of a large design group of forty engineers on the design of heavy mechanical equipment. Must have good background in electrical controls, structural, and internal-combustion engines. $12,000 and up. Location, New York, N. Y. Y-6114.

(*ASME News continued on page 960*)

[1] All men listed hold some form of ASME membership.



BOILER WATER LEVEL *Shines like a Star*

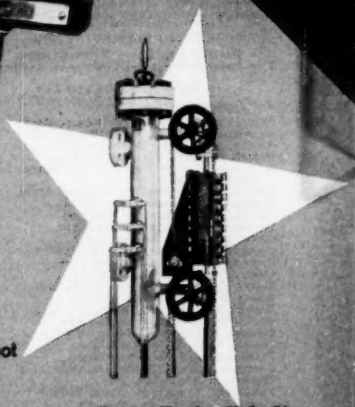
WITH YARWAY TYPE "M" ILLUMINATOR

Now you can *really* see that boiler water level.

Extraneous light, dust particles in the air, deposits on the gage glass—none of these stop the superior penetration of the blue-white light from the Yarway Type "M" Illuminator. It makes the meniscus at water level *stand out like a brilliant star.*

The Type "M" Illuminator is designed to give maximum brilliance, and spot the water level over its entire traverse. It's effective over longer distances.

Equip new or installed Yarway Flat Glass Gages with the Type "M" Illuminator for a new high in easy gage reading. For specifications and prices call your nearest Yarway office or write . . .



Yarway Floatless Hi-Lo Alarm Water Column with Vertical Pressure-Sealed Flat Glass Gage. Equipped with Type "M" Illuminator. For pressures to 2500 psi. See Bulletin WG-1311.

YARNALL-WARING COMPANY
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STEAM PLANT EQUIPMENT * * * **YARWAY**

Mechanical Designer, three to five years' experience in the design of automatic machinery, mechanisms, cams, etc. Knowledge of, or experience in, radio tubes or lamp-manufacturing machinery helpful. Will direct a group of designers. $7000–$8000. Newark, N. J. Y-6115.

Production Engineer, chemical or mechanical graduate, experienced in compounding rubber. Knowledge of synthetics helpful. $5000–$6000. Northern N. J. Y-6124.

Production-Design Engineer, mechanical graduate, some experience, for electrical metal products manufacturer. Must be capable of following product into production. $6700. Brooklyn, N. Y. Y-6126.

Sales Engineer, 27–40, mechanical graduate, sales experience, to call on architects, engineers, contractors, covering application, specifications, etc., of air-conditioning equipment, unit heaters, and radiation. Some traveling. $4800–$6000. Pittsburgh, Pa. Y-6138.

Methods Engineer, considerable experience in tooling and shop methods, particularly writing operation sheets, production planning, and sketching tools and fixtures. $5000–$6000. Northern N. J. Y-6169.

Building-Maintenance Engineer, 35–45, mechanical graduate, to take care of lighting, elevators, air conditioning, heating, office and building alterations, etc. $6000–$6500. Hoboken, N. J. Y-6173.

Utilities Engineer to lay out and revamp electric, steam, and water distribution systems; develop maps and easement file; and plan for expansion. Present system is 3500-kw steam plant at 650 lb, automatic telephone system and water-treating plant. $9000. Alaska. T-8152.

General Superintendent, 35–45, four to five years' experience in shop management in metal-working plants. Knowledge of modern manufacturing methods. Will supervise production, standards, processes, training, and production machinery, for metal-products manufacturer. Company may negotiate fee. $10,000. Ill. R-8159.

Development Engineer, mechanical, up to 38, at least three years' experience in hydraulic or lubrication development or testing. Will do development work on lubricating systems for industrial and automotive industries. Company will pay fee. $5200. Ill. R-8183.

Chief Operating Engineer, 40–50, ten years' experience in responsible operating of gas plants, including metering. Knowledge of natural-gas distribution. Informed about utility rates. Will take complete charge of natural-gas operations for utility. $7500. Wis. R-8189.

Hydraulic-Development Engineer, mechanical, 35–55, ten years' experience in centrifugal-pump design, particularly in nonclog types. Will do design and application of centrifugal pumps and supervision of draftsmen in design section for a manufacturer of pumps. Salary open. Ill. R-8212.

Assistant Mechanical Engineer, 25–35, up to five years' experience on maintenance and equipment design in mining or processing fields. Company may consider recent graduate. Knowledge of report writing. Will assist chief mechanical engineer on special assignments for mining and chemical company. Assignment on maintenance or engineering projects and may call for some design on the board. $3600–$6000. Considerable traveling. Ill. R-8220.

Design-Development Engineer, mechanical, several years' experience in design-development manufacturing. Experience on heavy equipment, mining equipment preferred. Knowledge of mechanisms, electrical control, and machinery applications desirable. Will be required to make field investigations; do some board work, and engage in engineering-department activities, for a manufacturer of mining equipment. Should have design ability, commercial slant, and potentialities for developing administrative ability. $6000–$7200. Ill. R-8256.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Nov. 24, 1951, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

For Member, Associate, or Junior

ACQUAVIVA, SAMUEL J., Roslindale, Mass.
ATCHISON, JAMES R., North Olmsted, Ohio
AWALT, ROBERT F., Baltimore, Md.
BAKER, ALBERT S., Kingsville, Texas
BARRADELL-SMITH, RICHARD, St. Helene, Lancashire, England
BREUWKER, REINIER, JR., Newton, Mass.
BHADI, V. G., Patna, Bihar, India
BHOTE, PUSI P., London, England
BUTCHER, W. C., La Canada, Calif.
CARP, JAMES, Los Angeles, Calif.
CHANDONNET, ARMAND T., W. Lynn, Mass.
CLARK, JOHN A., Cambridge, Mass.
DAGUE, MAX R., Akron, Ohio
DAVIS, GLENN N., Mexico, D. F., Mex.
DAVIS, RALPH B., Louisville, Ky.
DEWEY, LEO ARTHUR, Whitehall, N. Y.
DI SALVO, E. A., Cincinnati, Ohio
DROOGSCH, FRANK J., Detroit, Mich.
DYSON, R. L., Cedar Falls, Iowa
EILERS, CARL J., St. Paul, Minn.
EMMONS, NEAL L., Muskogee, Okla.
EXLINE, W. C., Salina, Kan.
FERGUSON, EUGENE S., Ames, Iowa
FERRIS, JOHN A., JR., Erie, Pa.
FINK, MARVIN E., Kansas City, Kan.
FURMAN, JACK H., Birmingham, Ala.
GILDERSLEEVE, LOIS, (Miss), Bridgeport, Conn.
GILMAN, FREDERICK C., Pompton Lakes, N. J. (Rt & T)
GRAHAM, P. M., Central Romana, Dominican Republic, W. I.
HARDY, C. C., Mexico, D. F., Mex.
HAWKINS, WILLIAM M., JR., New York, N. Y.
HENDRIE, PHILIP A., S. Charleston, W. Va.
HOFFMAN, FREDERICK J., Tampa, Fla.
HUMBLE, EUGENE A., Boston, Mass.
IMM, ARDEN L., Chattanooga, Tenn.
INCORVIA, JOSEPH, Euclid, Ohio
JACKSON, PHILIP B., N. Royalton, Ohio (Rt)
JACOBSON, JOHN S., Wilmington, Del. (Rt & T)
JUVINALL, ROBERT C., Indianapolis, Ind.
KARKOSKA, ANTHONY A., Brooklyn, N. Y.
KATHMAN, JOHN H., JR., Erie, Pa.
KERSHAW, CHET A., Portland, Ore.
KERSHAW, HAROLD, River Edge, N. J.
KINGSCOTT, R. A., Kalamazoo, Mich.
KNELL, C. VERNE, N. Canton, Ohio
LANDRY, WALTER A., JR., New Orleans, La.
LEFEVRE, GORDON, Mount Vernon, Ohio (Rt)
LEONARDY, SIDNEY P., Bartow, Fla.
LINDSAY, E. H., Houston, Texas
LUNDGREN, EDWIN, Frederick, Md. (Rt & T)
MALONEY, CORNELIUS, JR., Pittsburgh, Pa.
MARTINEZ DE LA TORRE, ANGEL M., Mayaguez, Puerto Rico
MCCULLOUGH, DAVID P., Woodbury, Conn.
MCINNES, ALEX, Wilmington, Del.
MILLER, R. W., Schenectady, N. Y.
MOOS, KASPER I., San Antonio, Texas
MUIR, JACK B., Walled Lake, Mich.
MYERS, WILLIAM P., Rock Island, Ill.
NELSON, EDWIN P., Chicago, Ill.
NOEL, ROBERT L., Freeport, Ill.
O'DONNELL, RAYMOND T., Seattle, Wash.
ODDEN, CLARENCE B., New York, N. Y.
OHL, RICHARD A., S. Orange, N. J.
OWENS, VINCENT P., New York, N. Y.
PALMQUIST, EVERETT W., Chicago, Ill.
PERRY, CHARLES C., Royal Oak, Mich.
PETERS, JOHN T., Schenectady, N. Y.
PRATT, F. W., Glastonbury, Conn.
RENFREW, J. M., Monterrey, N. L., Mex.
RICE, WARREN, College Station, Texas
RIBBS, MORTON L., Oak Park, Ill.
ROGERS, H. W., JR., Kansas City, Mo.
ROGERS, JAMES B., Spartanburg, S. C.
SCHULZ, P. G., Chicago, Ill.
SCHWENK, HENRY C., Chicago, Ill.
SINTES, FRED, JR., New Orleans, La.
SMITH, ARNOLD R., New York, N. Y.
SMITH, N. V., Los Angeles, Calif.
SMITH, RALPH W., New Castle, Del.
SPARHAWK, GEORGE H., JR., Prospect Park, Pa.
STANGELAND, LUDVIG B., Essington, Pa.
THOMPSON, ARTHUR J., Rossville, Ga.
TYLEE, JOHN S., Snyder, N. Y.
WALKER, ROBERT E., Columbia, Mo.
WATSON, W. T., Greenville, S. C.
WEARN, GEORGE E., Wayne, Pa. (Rt)
WEBER, WALTER O., Amityville, N. Y.
WEBSTER, RAYMOND D., Philadelphia, Pa.
WEIDNER, LOUIS J., S. Pasadena, Calif.
WELSH, JOHN W., Indianapolis, Ind.
WHITE, J. R., New York, N. Y.
WILES, JOHN H., Hagerstown, Md.
WILLIAMS, ROBERT W., Baton Rouge, La.
WONCH, NORMAN B., Jackson, Mich.
YOUNG, ROBERT L., Evanston, Ill.

CHANGE IN GRADING

Transfers to Member and Associate

ALBURGER, HARRY A., Washington, D. C.
BARDWELL, ARTHUR G., JR., Muscatine, Iowa
BURGESS, J. A., Wallaceburg, Ont., Can.
CAMPBELL, ALEXANDER B., Decatur, Ill.
DAVIS, G. MASLIN, Wilmington, Del.
DILG, WALTER C., Hewlett, N. Y.
GIBSON, F. M., JR., Forest Hills, N. Y.
HAMBLETON, WARNER V., Dallas, Texas
HARLEY, JAMES A., Montreal, Que., Can.
HEMSARTH, JOHN H., Philadelphia, Pa.
HOCK, FREDERICK R., Bethesda, Md.
HORVATH, GUY E., Manheim, Pa.
JOHNSON, WILLIAM F., Memphis, Tenn.
LEAVENGOOD, WILLIAM H., Savannah, Ga.
LESSER, MURRAY L. Los Angeles, Calif.
MCCLELLAN, STEPHEN A., Syosset, L. I., N. Y.
MCKINLEY, JAMES M., Baltimore, Md.
MCLANE, ROYE M., Baltimore, Md.
MITCHELL, WILLIAM H., Lima, Ohio
MOYER, ROBERT G., Des Plaines, Ill.
ORMOND, ALEX C., Savannah, Ga.
PETERSON, GEORGE E., San Francisco, Calif.
PLANCK, IVAN A., Ft. Wayne, Ind.
ROBINSON, WILLIAM A., Cleveland, Ohio
SAN FANANDRE, ALBERT J., Valley Stream, L. I., N. Y.
SANTUCCI, EDWARD D., Newark, N. J.
SHEPPARD, EDWARD K., Charlotte, N. C.
TALMAGE, A. A., Scarsdale, N. Y.
TOELKE, LESTER W., Houston, Texas
VAN DYCK, W. C., Washington, Ill.
VOGEL, ERWIN, N. Valley Stream, N. Y.
WARE, MARSDEN, Huntington Woods, Mich.
ZIEBOLZ, HERBERT, Chicago, Ill.
ZINK, GEORGE A., Detroit, Mich.

Transfers from Student Member to Junior 300

Obituaries

Leslie Douglass Anderson (1879–1951)

L. DOUGLASS ANDERSON, consulting engineer, Potash Company of America, Carlsbad, N. Mex., died July 31, 1951. Born, Ishpeming, Mich., March 27, 1879. Parents, Charles Ludwig and Ella (Norberry) Anderson. Education, BSME, University of Michigan, 1901. Married Mabel Hoyt Cooley, 1907. He held several U. S. patents and was the author of many technical articles. His work as consultant in engineering took him to Australia for the Mining Trust of England and from 1930–1933 his work with Freyn Engineering Co., Chicago, Ill., took him to Siberia and all over Russia. Assoc. ASME, 1906; Mem. ASME, 1913. Survived by wife and three children, Mrs. Max Werminghaus, Munich, U. S. Zone, Germany; Paul D., San Rafael, Calif.; Dan R., Tucson, Ariz.; two grandchildren and a great-grandchild.

John Avery (1902–1951)

JOHN AVERY, president and general manager, Roots-Connersville Blower Corp., Connersville, Ind., died Jan. 13, 1951. Born, Hull, Mass., Aug. 23, 1902. Education, BS, U. S. Naval Academy, 1923. Mem. ASME, 1946.

Nicholas Blumberger Borda (1900–1951)

NICHOLAS B. BORDA, general superintendent, Cementos Mixcoac, S. A., Mexico, D. F., Mex., died Aug. 3, 1951. Born, Eger, Hungary, April 24, 1900. Parents, Joseph Blumberger and Rose (Braun) Borda. Education, ME, German Technical University, Brünn, 1923. Married Elena Hartman, 1935. Mem. ASME, 1950. Survived by wife and two children, Peter and Eve.

Gordon Saulman Brick (1914–1951)

GORDON S. BRICK, aeronautics engineer, Naval Aircraft Factory, Naval Base, Philadelphia, Pa., died Feb. 28, 1951, at Temple University Hospital. Born, Philadelphia, Pa., June 7, 1914. Parents, Harry and Elizabeth (Abuhove) Brick. Education, BSME, University of Pennsylvania, 1937. Jun. ASME, 1937. Survived by parents.

(*ASME News continued on page 962*)

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William Neilson Brownlie (1898–1951)

WILLIAM N. BROWNLIE, resident manager, Mutual Boiler Insurance Co. of Boston (Mass.), died May 19, 1951. Born, Rhu, Dunbartonshire, Scotland, Aug. 15, 1898. Parents, Malcolm and Jessie Ann (Moultrie) Brownlie. Education, Leith Technical College, Edinburgh, Scotland, 1921; University of Edinburgh, 1923; special courses, Massachusetts Institute of Technology, 1936. Naturalized U. S. citizen, Boston, Mass., Jan. 11, 1932. Married Edith Mary Nicoll, 1922. Mem. ASME, 1942.

Charles Bradford Cole (1888–1951)

CHARLES B. COLE, president, Tool Equipment Co., Chicago, Ill., died July 23, 1951. Born, Orange, N. J., Nov. 18, 1888. Parents, Arthur Bradford and Elizabeth (Couhig) Cole. Education, graduate Orange (N. J.) High School; one year technical school. Married Josephine Forgone. Author of a textbook on tool design; several articles published in technical and trade journals. Jun. ASME, 1919; Mem. ASME, 1926. Served the Society as chairman, Chicago Section, 1930–1931. Survived by wife and four children, Mrs. Marian McElroy, Mrs. Adeline Abram, James B., and Stephen A.

John Gilbert Collison (1892–1951)

JOHN G. COLLISON, manager, head of The Surgical Engineering Co., Baltimore, Md., died Feb. 8, 1951. Born, Erin, Tenn., May 18, 1892. Education, ICS (mechanical engineering). Mem. ASME, 1949.

Floyd Alexander White Hale (1891–1951)

FLOYD A. W. HALE, mechanical engineer, Pacific Division, Link-Belt Co., San Francisco, Calif., died in Clarksville, Ind., Jan. 9, 1951. Born, Dennison, Texas, Oct. 24, 1891. Education, BSME, University of Louisville, 1914. Mem. ASME, 1941.

Sidney Hosmer (1871–1951)

SIDNEY HOSMER, former vice-president and general manager, Boston (Mass.) Edison Co., died Aug. 27, 1951, at his home in New York, N. Y. Born, Pinner, Middlesex, England (of American parents), July 13, 1871. Parents, George and Agnes (Tatum) Hosmer. Education, BA, Yale University, 1892. Married Marguerite Christian, 1938. Mem. ASME, 1902. Survived by wife and two children by a previous marriage, Mrs. John H. Magruder, Washington, D. C., and Charles Town, W. Va.; and Henry B. Hosmer, Boston and Concord, Mass.

Everett Wheeler Howe (1900–1951)

EVERETT W. HOWE, plant engineer, United States Rubber Co., Providence, R. I., died May 24, 1951. Born, South Berlin, Mass., May 17, 1900. Parents, Chester A. and Grace R. (Blodgett) Howe. Education, BS, Massachusetts Institute of Technology, 1922. Married Mildred MacMahill, 1929. Jun. ASME, 1937. Survived by wife and two children, Robert J. and Cordelia B.

Emil Lambert Larson (1894–1951)

EMIL L. LARSON, stress analyst, North American Aviation, Inc., Downey, Calif., died on July 30, 1951. Born, Chicago, Ill., Feb. 4, 1894. Parents, Lambert and Emily (Hultgren) Larson. Education, BS, University of Chicago, 1926. Married Lenora Fluhrer, 1916. Mem. ASME, 1929. Survived by wife.

Louis E. Lovett (1891–1951)

LOUIS E. LOVETT, of the firm of Louis E. Lovett, Engineers, Madison, Ohio, died July 11, 1951. Born, New York, N. Y., June 10, 1891. Parents, Emil and Lena (Smadbeck) Lovett. Education, EE, Columbia University, 1912; Chem. E., 1931–1932. Married Hermine Robitschek, 1915; children, Lois and Peter. Mem. ASME, 1928. He wrote several technical papers which were published in trade journals.

Jack Arthur Martin (1888–1951)

JACK A. MARTIN, engineer, Interstate Commerce Commission, Pittsburgh, Pa., died May 1, 1951. Born, Loveland, Colo., May 31, 1888. Parents, Zachary and Ann Elizabeth Martin. Education, BSME, University of Colorado, 1909. Married Ima Smith, 1929; children, Helen Elizabeth and Dolores. Assoc-Mem. ASME, 1931; Mem. ASME, 1935. Author of several articles on railroad engineering.

Joseph Merritt (1868–1950)

JOSEPH MERRITT, president and director, Hartford (Conn.) Special Machinery Co. and an officer in other companies, died Jan. 3, 1950. Born, Greenwich, Conn., Feb. 6, 1868. Parents, Robert Tucker and Julia (Pickett) Merritt. Education, high-school graduate. Married Alice Virginia Pattison, 1903 (died Oct. 17, 1950). Mem. ASME, 1907. He held many food-packaging patents. Survived by three children, Robert P., Hartford, Conn.; Philip J., West Hartford, Conn.; and Mrs. Reginald M. Helfferich, Bath, Pa.

Fred Constine Morton (1887–1950)

FRED C. MORTON, general superintendent, Savannah (Ga.) Electric and Power Co., died Oct. 21, 1950. Born, Sand Lake, Mich., May 3, 1887. Parents, Charles and Abbie (Brockway) Morton. Education, BSEE, University of Maine, 1908. Married Mary Wotring Henry, 1947. Mem. ASME, 1948. Survived by wife.

Ray Chauncey Newhouse (1875–1951)

RAY C. NEWHOUSE, consulting engineer, who retired in 1945 as manager and chief engineer of the basic industries department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., died Aug. 27, 1951. Born, Magnetic Springs, Ohio, Jan. 1, 1875. Parents, John and Frances (Brown) Newhouse. Education, attended Ohio Wesleyan University, 1889–1892. Married Mabel A. Dearness, 1908; daughter, Margaret Frances (Mrs. J. M.) Swan. He held about 100 U. S. patents and many foreign patents covering the Newhouse crusher, compeb mill, and other machinery and methods for the manufacture of Portland cement and the reduction of ores and rocks. He was recognized as an authority on the design of Portland cement plants; he wrote several papers for trade publications on the subject. Received the Modern Pioneer Award from NAM in 1940. Mem. ASME, 1920; Fellow ASME, 1948.

Norman Finch Robertson (1899–1951)

NORMAN F. ROBERTSON, president, general manager, John Robertson Co., Inc., Brooklyn, N. Y., died Aug. 26, 1951. Born, Brooklyn, N. Y., April 5, 1899. Parents, Norman A. and Jenny (Finch) Robertson. Education, attended Stevens Institute of Technology. Married Mary Katherine McCoy, 1925; daughters, Frances (Mrs. Kent Chandler, Jr.) and Gail. Assoc. ASME, 1930.

William Bernard Sommer (1885–1951)

WILLIAM B. SOMMER, department head on U. S. Navy Project, Westinghouse Electric Co., Sunnyvale, Calif., died July 11, 1951. Born, Essen, Germany, Feb. 22, 1885. Parents, William B. and Anna (Proese) Sommer. Education, graduate of technical junior college, 1903; mechanical-engineering course, University of Minnesota Extension Division. Married Ida M. Petry, 1943. Mem. ASME, 1943. Survived by wife and daughter, Mrs. Ellen S. Stanley.

Norman William Sultzer (1892–1951)

NORMAN W. SULTZER, eastern sales manager, Research Corp., New York, N. Y., died in Overlook Hospital, Summit, N. J., Aug. 11, 1951. Born, Yonkers, N. Y., May 1, 1892. Parents, Frederic K. and Alice (Silvernail) Sultzer. Education, BS, New York University, 1915; CE, 1916. Married Isabella Grant, 1919. Mem. ASME, 1941. Survived by wife, a daughter, Mrs. Nancy (Carl H.) Mortimer, Greenwich, Conn.; a son, Norman W., Jr., Westport, Conn., and two brothers, Kenneth and Carl.

Hervey Sackett Vassar (1877–1951)

HERVEY S. VASSAR, retired laboratory engineer, Public Service Electric and Gas Company of N. J., died Aug. 30, 1951, at his home in Bloomfield, N. J. Born, Flemington, N. J., Dec. 28, 1877. Parents, Thomas B. and Tamma G. (Sackett) Vassar. Education, industrial-engineering course, Pratt Institute, 1903. Married Helen T. Provost, 1910. Mem. ASME, 1914. Past-president ASTM. He was active in community affairs and in 1945 was chosen as Bloomfield's outstanding citizen. Survived by wife, two sons, Hervey P. and Thomas E.; a daughter, Eunice; and a sister, Mrs. A. V. Morton.

Pearson Winslow (1893–1950)

PEARSON WINSLOW, retired, industrial banker, died Dec. 13, 1950. He resided at The Beekman, New York, N. Y. Born, Jamestown, R. I., Sept. 1, 1893. Education, PhB, Sheffield Scientific School, Yale University, 1915. Assoc-Mem, ASME, 1921; Mem. ASME, 1935.

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has no parts to loosen or work out

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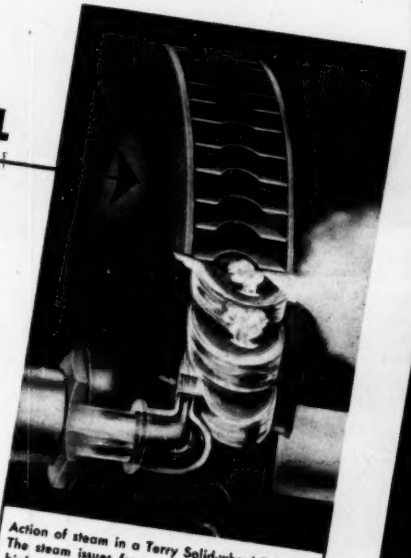
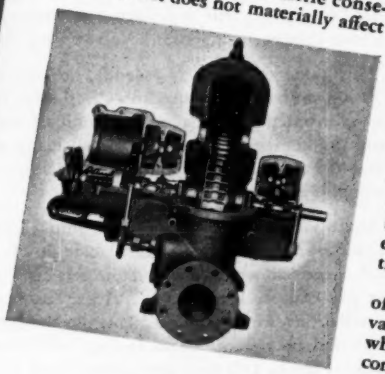
The power-producing action of the steam takes place on the curved surfaces at the back of the buckets. Hence, wear of the blades is of little consequence, as it does not materially affect horsepower or efficiency. There is practically no end thrust since the steam enters and leaves the wheel in a direction at right angles to shaft.



Action of steam in a Terry Solid-wheel Turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.



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THE TERRY STEAM TURBINE CO.

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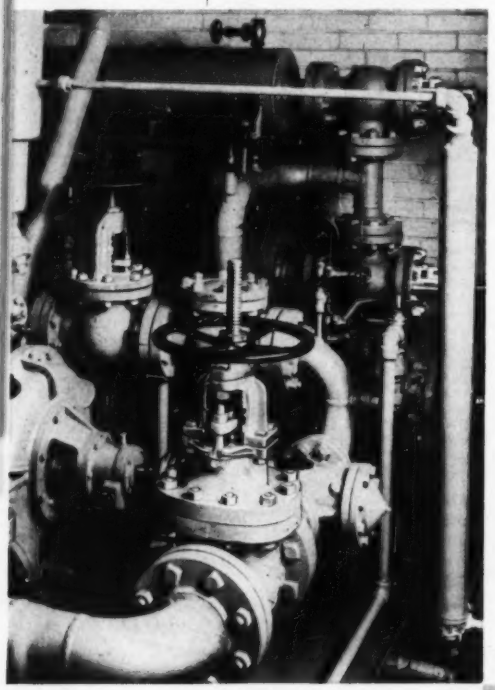

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1 DIE-LESS DUPLICATING

O'Neil-Irwin Mfg. Co.—Hydraulic Power Bender, Variable Speed Powershear, and Air Powered Rod Parter have all been added to the "Di-Acro" Line to increase the production possibilities of the "Di-Acro" System of Die-Less Duplicating. 40-page "Di-Acro" Catalog contains complete information covering these power machines as well as all manually operated "Di-Acro" benders, brakes, shears, rod parters, notchers, and punches, which are offered in a variety of sizes.

2 FLUID POWER EQUIPMENT

Oilgear Co.—New 8-page Bulletin 10051-B illustrates and describes complete line of fluid power pumps, motors, transmissions, cylinders, and valves. It features a new line of constant delivery pumps for pressures up to 5000 psi and variable delivery pumps, a new line of axial piston motors, and improved line of standard cylinders for pressures up to 1500 psi, and a new line of heavy-duty cylinders for pressures up to 3000 psi. It introduces standard line of pilot and directional control valves, relief and foot valves, surge (pre-fill) valves, combination valves, differential valves, and auxiliary fluid equipment for pressures up to 3000 psi.

3 SOLENOID VALVES

Ruggles-Klingemann Mfg. Co.—Additional pages for catalog E on electrically operated valves now being printed showing new designs and typical applications. This catalog contains complete information for valves from 1/4 to 12 in.

4 STEAM GENERATORS AND FURNACES

Petro-Chem Development Co.—Two Technical Bulletins: 50-1 and 50-2, which describe and illustrate Iso-Flow Steam Generators and Iso-Flow Furnaces. Bulletin 50-2 contains a detailed summary of the design and operating characteristics and operating test data on a 30,000 lb per hr Iso-Flow steam generator installation. Bulletin 50-1 describes and illustrates the Petro-Chem Iso-Flow furnace, radiant convection design, and includes the significant design and operating characteristics of these cylindrical furnaces which are in extensive use throughout the petroleum, chemical, and allied industries.

5 WROUGHT IRON PIPE

A. M. Byers Co.—To assist technicians in design and specification work, a 4-page bulletin contains the most frequently required data on wrought iron pipe. Consolidated tables list size and dimensional data for both standard and extra strong pipe. Complete information on threads per in., mill test pressures, circumference, external areas, length per sq ft of surface area, length per cu ft of volume, gal per lineal ft, and weight of water per lineal ft, is given.

6 CUTTING FLUIDS

D. A. Stuart Oil Co.—A reliable guide to better machining through proper selection and application of cutting fluids is offered. Contains handy chart which aids in selecting cutting fluids for various metal-working operations. Two articles—"Mechanisms of Metal Cutting" and "Chemistry of Cutting Fluids" will help the shop man to better understand cutting-fluid functions and enable him to obtain more efficient operation.

7 FINTUBES

Brown Fintube Co.—Latest data on construction, application, and engineering of Brown Integral "one-piece" Fintubes, is given in a new bulletin, including comparisons of external surface of bare pipe or tubing with longitudinally finned pipe or tubing.

8 BROACHING MACHINES, PRESSES

Oilgear Co.—Bulletin No. 10052A, contains complete specifications and condensed information on their standard line of Fluid Power Broaching Machines and Presses, illustrates and describes diversified special machines, and lists the fluid power components manufactured for direct and resale purposes.

9 GRATING—FLOORING, SAFETY TREADS

Irving Subway Grating Co.—Catalog No. F-225 contains illustrations, descriptions, and engineering data on fireproof, durable, safe, clean, and economical gratings and safety steps (riveted, pressure-locked, and welded) for industrial plants, power plants, refineries, ships, railroad freight and passenger cars, and locomotives, open steel-mesh bridge decking, etc.

10 STEAM TRAP PROBLEMS

V. D. Anderson Co.—Bulletin No. 151, entitled "Solving Steam Trap Problems," contains 36 pages of illustrations, drawings, and charts, describing the importance of trap selection and showing application for various industries.

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11 ROLLER CHAINS AND SPROCKETS

Diamond Chain Co., Inc.—A new 112-page engineering catalog No. 649 containing complete information on roller chains and sprockets for industrial power transmission is offered. Engineering information relative to the application of roller chain drives is presented.

12 ROLLED AND WELDED STEEL PRODUCTS

Cleveland Welding Co.—Bulletin No. W-500 describes Cleve-Weld circular, rolled, and welded steel products. Various types of circular weldments and accompanying advisory service are illustrated.

13 HYDRAULIC "OIL" POWER EQUIPMENT

Vickers, Inc.—Bulletin No. 5000 contains general design information and specifications of a complete line of pumps, valves, controls and related equipment for oil hydraulic power transmission in machine-tool and general industrial field. Individual units, also standardized or custom-built power units, transmissions, and control panels available.

14 WARREN-QUIMBY SCREW AND ROTEX PUMPS

Warren Steam Pump Co.—Bulletins S204 and WQ-50 illustrate and describe these two distinctly different types of rotary pumps, both built with internal and exterior gears, horizontal or vertical mounting, and in a variety of metals. Screw-pump capacities to 3000 gpm and Rotex to 100 gpm.

15 CHAIN DRIVES

Morse Chain Co.—Catalog No. C55-50 covers immediately available sizes of roller chains and sprockets. Contains complete dimensions, list prices, and horsepower ratings. Types A, B, and C sprockets are listed. Engineering information on drive selection, calculation of chain lengths, lubrication, installation, and maintenance of roller chain drives.

16 COAL-HANDLING EQUIPMENT

Bartlett-Snow—Bulletin No. 103 describes central station coal-handling equipment including a complete design, engineering, fabricating, and erection surface. Many illustrations of Bartlett-Snow equipment in operation are provided.

17 SUPER REFRACTORIES

Carborundum Co.—"Super Refractories for Boiler Furnaces," gives description of product properties, how they are put to work in various furnaces, and the benefits they provide. Many setting and application drawings, tables, and charts of special interest to boiler operators in both utility and industrial plants are included.

18 BULK MATERIALS BIN LEVEL INDICATOR

Bin-Dicator Co.—20-page bulletin fully describes and illustrates bin level indicator which gives automatic control of machinery in response to fluctuating level of materials in silos, bins, hoppers, etc. Dimensional drawings, mounting details, typical applications, wiring diagrams, and revealing list of present users. Illustrated applications to stoker operation, flour packing, chemical proportioning, concrete mixing plant, packaging ores, salt, feed, chemicals, candy, etc.

19 ROLLER CHAIN FLEXIBLE COUPLINGS

Baldwin-Duckworth Div., Chain Belt Co.—New illustrated 8-page catalog gives complete data on roller chain couplings and how to select them, and on coupling covers and their advantages. Also contains specification data with many tables and charts on permissible angular and radial misalignments, tables on bore tolerances, etc.

20 NONRETURN VALVES

Golden-Anderson Valve Specialty Co.—Cushioned triple-acting nonreturn valves for steam control in case of damaged boilers or headers are described in a new 8-page bulletin. Included in the bulletin are a complete technical description, engineering diagrams of the three different body and yoke patterns, a parts list, and operation and installation instructions.

21 PNEUMATIC ATOMIZING NOZZLES

Spraying Systems Co.—11-page illustrated catalog No. 23 lists wide range of types, sizes, and materials as standard equipment to meet exact needs in capacities, spray types, and characteristics for atomizing any liquid that flows; for industrial and chemical processing and scientific research.

22 WELDING FITTINGS AND STEEL FLANGES

Tube Turns, Inc.—Chart of Pipe and Fittings Materials. Quick-reference chart covering ASTM and

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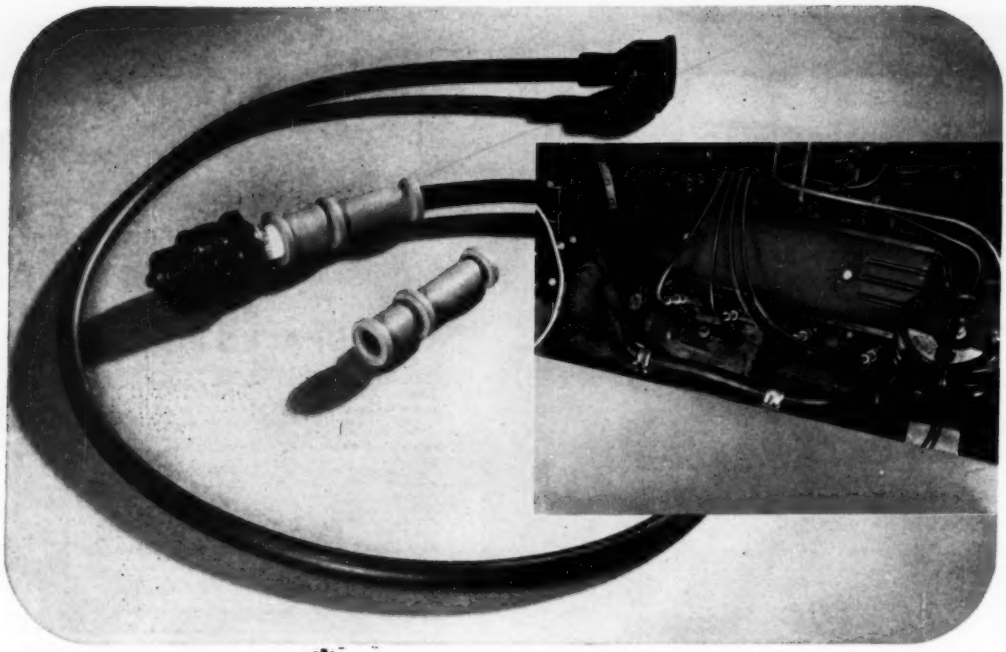

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23 DUST CONTROL

W. W. Sly Mfg. Co.—A revised 20-page treatise, bulletin No. 98, on industrial dust collection discusses the principles of dust control by filtration, determination of air volume, hood design, piping, and other features, and contains numerous diagrams, tables, and other valuable information.

24 GEARS, ETC.

Boston Gear Works—Catalog No. 55 gives complete information and prices on over 4500 stock items including spur, miter, bevel, helical, and worm gears, roller chains, sprockets, ball bearings, pillow blocks, couplings, pulleys, speed reducers, ratiomotors, and oil-impregnated porous bronze bearings. It provides engineering data, formulas, horsepower rating charts, reference tables, and selection charts for figuring the correct power drive and selecting the proper equipment for virtually every mechanical power transmission.

25 ELECTROSHIELD COPPER CLAD METAL

American Cladmetals Co.—A new booklet entitled "Electroshield, the *New* Copper Clad Metal" is of vital importance to every user of copper, especially during these days of scarcities, because of two major reasons. First, ElectroShield saves up to 80% of copper; second, it can be used for most applications where copper sheets are now employed, and more. This booklet provides the answer to many a present-day production problem where copper restrictions might cause serious upsets in design.

26 SK EQUIPMENT

Schutte & Koerting Co.—New products list folder, entitled "Index of SK Equipment and Descriptive Bulletins," lists SK products according to application and alphabetically, together with the numbered descriptive bulletin pertaining to each product.

27 STEAM GENERATORS

Titusville Iron Works Co.—Bulletin B-3250A describes the Titusville Ticotherm steam generators. The catalog describes the small operating space required and the low cost and maximum steam output. Dimensions, drawings, and predicted performance curves are included.

28 MINIATURE BALL BEARINGS

Miniature Precision Bearings, Inc.—New 12-page Catalog, illustrated with comprehensive specifications on more than 70 types and sizes of standard miniature ball bearings from 1/2 mm to 9/8 in. OD. Includes material of particular interest to designers of precision mechanisms—applications, lubrication, design variations, special bearings, etc.

29 EFFECTS OF CHECK VALVES IN IN OVERCOMING WATER HAMMER

Williams Gauge Co.—The cause, effect, and control of water hammer in piping systems are considered in a new 8-page bulletin. After describing water hammer in nontechnical terms, the brochure indicates its potential damage to piping, instruments, and other parts of water systems, and then considers methods of controlling it.

30 HIGH VACUUM APPARATUS

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31 PIPING FABRICATION AND ERECTION

Dravo Corp.—A 24-page illustrated booklet, bulletin No. 1700, shows piping installations in steel mills, for gas transmission systems, central power stations, water pumping stations, heating plants, oil refineries, and chemical process plants. Dravo's engineering and fabrication facilities are also illustrated and described.

32 STEEL BOILERS

Kewanee Boiler Corp.—Kewanee Steel Boilers. Lo and Hi Pressure Series. Welded and Riveted for mechanical or hand-firing and convertible. Steam radiation ratings 1380 to 42,500 sq ft commercial, 330 to 3000 sq. ft residential sizes. Shown in 24-page General Catalog 80.

33 INDUSTRIAL TRUCK FAILURES

Baker Industrial Truck Div. of Baker-Raulang Co.—The Care & Maintenance of Industrial Trucks, important in protecting your investment and assuring continuity of service, is the subject of this new manual. This 16-page bulletin contains 51 illustrations of the steps to be taken in preventive maintenance and annual check-ups.

34 METAL BENDING

O'Neil-Irwin Mfg. Co.—New 32-page bending manual contains information on a wide variety of forming operations. The bending of tubing, angle, channel, extrusions as well as solid materials is graphically illustrated. Detailed prints show the exact manner in which any rotary-type bending machine can be tooled for precision bending. The manual outlines the recommended steps in designing parts to be formed, choice of materials, and selection of bending equipment.

35 INDUSTRIAL METER SELECTION

Rockwell Mfg. Co.—A new bulletin, No. OG-400, intended to guide the proper selection of meters for measuring more than 200 chemicals, petroleum products, and other liquids with varying corrosive characteristics is available. In addition to the complete table of metered liquids matched with case, chamber, and piston specifications, the bulletin also includes a simplified specification sheet which makes it easy for the customer to cover all necessary operating requirements so that proper meter recommendations can be made at the factory.

36 FLEXIBLE COUPLINGS

Lovejoy Flexible Coupling Co.—Illustrated Catalog with Selector Charts. Grouping and application of L-R Flexible Couplings. Describes and pictures various types of couplings, with cutaway views and diagrams. New couplings for d-c standard mill motors. Selector Charts make it easy to choose correct type and size of coupling with proper cushion material for application.

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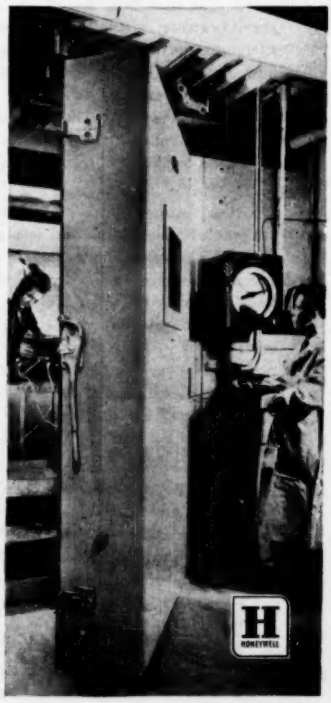
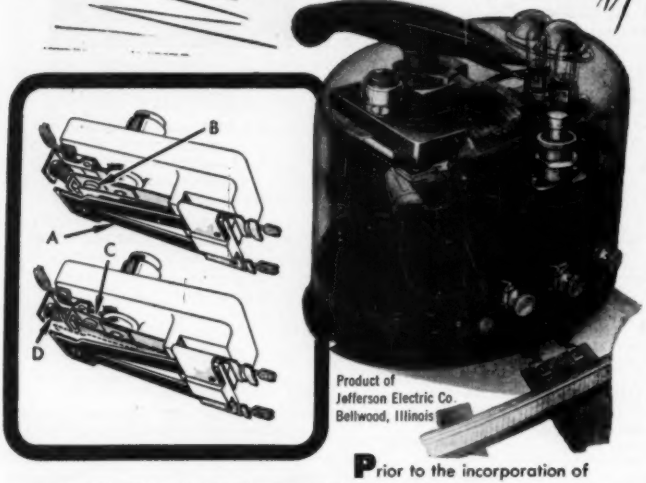
You can—at Honeywell—if you're a graduate mechanical or electrical engineer. Because right now we have some desirable openings in our Aeronautical Division—good, interesting jobs analyzing the performance of controls in the finest lab of its kind in the world. Besides the "Arctic Room" pictured, there is a high-humidity chamber—and a dozen other set-ups for subjecting controls to the most rugged tests. Work is constantly being done in hydraulics, vibration, servomechanisms, frequency response, jet engine control and many other fields. So if you're a graduate ME or EE who would like a really *interesting* job, let us hear from you. Send your letter to Mr. H. D. Elverson, Personnel Dept. ME-3, Minneapolis-Honeywell, Minneapolis 8, Minnesota. Give full background. Your correspondence will be held in the strictest confidence, of course.

MINNEAPOLIS **Honeywell**

First in Controls



Safety for the Lilliput Limited when CHACE flashes the Signals



Prior to the incorporation of circuit breakers in transformers, overloading and short circuiting of miniature electric train systems were the causes of many fires. This new Jefferson Toy Transformer provides complete protection for transformer, train and equipment. When all's well, the green light burns—but when an overload or short occurs, the red light flashes on and the entire circuit is broken before damage can be done. When the trouble is corrected, pressing the re-set button re-establishes the circuit.

The exaggerated perspective drawing shows the Chace Thermostatic Bimetal slotted into a "hairpin" element "A". It will carry the normal current without response but when an overload occurs, resistance to the increased current causes the bimetal to heat up; the high responsive side being down, the bimetal bends upward, opening the main contacts "B" and closing the red light contacts "C". The coil spring "D" locks the contact in an open position as the bimetal cools and resumes position. When the trouble is corrected, the re-set is pushed down, the red light circuit is broken and the coil spring "D" holds the main circuit contacts together for the continued operation.

Jefferson Electric fabricates this element from Chace #2600 strip. The 29 types are also available in random coils or in elements fabricated and assembled to customer specifications. Ask for our 64-page reference on thermostatic bimetal element design, then consult the Chace Applications Engineers before you proceed with development of your own temperature responsive device.

W. M. CHACE CO.
Thermostatic Bimetal
1619 BEARD AVE., DETROIT 9, MICH.

CATALOG CURRENT

37 LUBRICATION

Universal Lubricating Systems, Inc.—Universal hydraulic grease fittings, couplers, swivel couplers, control handle for boosting grease pressures to 12,000 lb, and top oiler for upper cylinder lubrication are illustrated and described in a 14-page 1951 Industrial Catalog.

38 HYDRAULIC ELECTRIC POWER UNITS

American Blower Corp.—Gyrol Fluid Drive Hydraulic Electric Power Units. "Power in a Package" pictorially described in Bulletin No. 8519. Bulletin mentions applications, shows illustrative test photographs, and includes ratings and dimensions.

39 HYDRAULIC JACK

Duff-Norton Mfg. Co.—The "Lo-Hite" hydraulic jack, designed for lifting jobs in confined positions otherwise impossible of access, is featured in Bulletin AD 3-549. With a capacity of 30 tons and a closed height of only 4 1/2 in., this equipment is composed of a jacking mechanism, a connecting length of hydraulic hose, and an independent pump.

40 ACTUATING CYLINDERS

Ledeen Mfg. Co.—Informative bulletin No. 500, illustrates and describes complete line of actuating cylinders for air, oil, water, or steam operation. Bulletin shows detailed features, reasons for selecting medium-duty, heavy-duty or super-duty cylinders; dimensions and weights; ratings and limitations; rod and head attachments, and complete specifications. Bulletin is valuable guide to engineers, designers, maintenance men, and others whose equipment must push or pull, lift or lower, press or squeeze, tilt or turn, open or close.

41 COPPER AND COPPER-ALLOY FORGINGS

American Brass Co.—A revised edition of its handy reference booklet on copper and copper-alloy die pressed forgings, is available. The 12-page booklet provides practical, to-the-point, comparative illustrations to show what die pressed forgings are, what they can do, what they have already done, what a manufacturer can expect of them. Tabulation of physical properties of copper and copper alloys suitable for forgings is included.

42 COMPRESSOR VALVES, PLATES, DISCS

J. H. H. Voss Co., Inc.—Literature describes Voss valves and Voss plates and discs which are applicable to any make, size, and type of air, ammonia, or gas compressors, including all the different refrigerating media; air, hydrogen, oxygen, gas, and corrosive media in vacuum pump application. Available to manufacturers of new machinery as well as to users for replacements. Voss valves and valve plates are designed for each individual job and made on special machinery from the alloy or stainless steel best suited to the conditions under which they are to operate.

43 BRIDGE CRANES

Shepard Niles Crane and Hoist Corp.—Bulletin Nos. 179–180 illustrate and describe floor and cab-controlled electric traveling cranes in capacities from 1 to 450 tons. Grab bucket, gantry-wall, or jib cranes installations actually shown. If interested in cab controlled monorail hoists, request bulletin No. 177. These pictorial Bulletins actually show what has been done and what can be accomplished in cost reduction by employing proper material handling.

44 AUTOMATIC CONTROLS

Mercoid Corp.—A complete line of automatic controls and mercury switches are illustrated and described in Mercoid catalog No. 700A. These electrically operated controls cover a wide range of applications involving the automatic control of pressure, temperature, liquid level, and for lever arm mechanical operations. Various types of mercury switches are made in numerous circuits.

45 POWER PRESSES

V & O Press Co., Div. of Emhart Mfg. Co.—Catalog available describing inclinable presses, bench presses, double-action presses, punch presses, arch presses, horning and wiring presses, reducing presses, foot presses, notching presses, high-speed presses, straight-sided presses; automatic roll feeds, dial feeds; feed-o-matic (punch-press feeder); automatic threading and trimming machines.

46 MINIATURE BALL BEARINGS

New Hampshire Ball Bearings, Inc.—Technical bulletin No. 50 lists a full line of ground miniature bearings, including the only miniature Conrad (retainer) bearings manufactured in the U. S.

"Rudolph Says He Knows The Taps Would Last Longer If He Had The Right Cutting Fluid On The Machine"

USE OF the *right* cutting fluid for the job *makes taps last longer,* conserves critical tool steel, minimizes downtime, increases output. A typical example:

A large instrument manufacturer changed to Stuart's THREDKUT for tapping Allegheny metal . . .

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You just cannot ignore the fact that the cutting fluid used is a major factor in any machining operation. A Stuart Representative is prepared to show you how Stuart combines theory and practice to give you better operating performance. Ask to have him call.

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CONSERVE TOOLS
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47 STEAM CONDENSERS

Condenser Service & Engineering Co.—Bulletin No. 102 describes steam surface condensers up to 70,000 sq ft for power and process plants. Engineering design and performance data explained and simplified. Full description of condenser auxiliaries and maintenance aids for the operator. Bulletin covers both theoretical and practical consideration, fully illustrated by photographs, drawings, and charts.

48 ELECTRIC MOTORS

Howell Electric Motors Co.—"Red Band" Motors customers' price catalog available and also descriptive bulletins separately describing motor types including general-purpose squirrel-cage induction motors totally enclosed, elevator motors, explosion-proof, multispeed and sanitary motors, and also a bulletin on fractional horsepower ratings. Also condensed price sheets and bulletins AC-2 are available, the latter listing recommendations for various types of motors used on typical applications. The company specializes in industrial a-c motors from 1/18 to 200 hp.

49 LUBRICATION

Lubriplate Div., Fiske Bros. Refining Co.—Newly revised 56-page lubriplate Data Book contains much valuable information on the subject of lubrication and includes product description and correct recommendations for machinery in all industries.

50 MOTOR BASE

Lovejoy Flexible Coupling Co.—Illustrated catalog sheet on new tilting motor base for fractional hp motors, gives full description and specifications for low-priced adjustable motor base. Besides its use with variable-speed pulleys, it also acts as a belt tightener.

51 ASH HANDLING SYSTEMS

Beaumont-Birch Co.—Booklet gives detailed information on both hydraulic and pneumetic ash and flyash handling systems and the elements and advantages of each. Schematic drawings and diagrams of basic arrangements are included.

52 FOAM RUBBER, SPONGE RUBBER

Sponge Rubber Products Co.—New 12-page folder illustrates shapes and forms, into which cellular rubber can be molded or die cut—tubing, cord, strips, sheets, rolls, pads. Describes typical applications in sealing, insulating, gasketing, dust proofing, weather stripping, sound deadening, shock absorption. Offers experimental examples.

Continued on Page 48

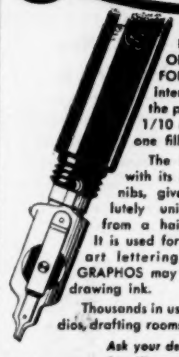
The Latest Industrial Literature

offered in this list represents recently issued Catalogs, Bulletins, Handbooks, Data, Booklets, Charts, Informative Folders and other engineering information made available by current advertisers in ASME Publications.

54 Pens in One!

WORLD'S ONLY DRAWING INK FOUNTAIN PEN WITH Interchangeable Nibs

Pelican Graphos



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WITH Ledeen CYLINDERS

Ledeen CYLINDERS

For straight line power movement. Air, oil or water operation. Medium Duty, Heavy Duty, and Super Duty models.

Write for Bulletin 500.

Ledeen VALVES

For actuating air or hydraulic cylinders. 14 different models for 5 different cycles, in 6 sizes. Hand, foot and power operated.

Write for Bulletin 510.

Ledeen VALVE ACTUATORS

For actuating any make, size and type of valve, against any line pressure, on any fluid medium, and with any pressure available. For on-and-off or positioning service. Positive in action, economical in cost.

Write for Bulletin 512.

Ledeen Mfg. Co.
1600 San Pedro
Los Angeles 15, Cal.

FREE LITERATURE GUIDE

53 CORROSION RESISTANCE OF COPPER AND COPPER-ALLOYS

American Brass Co.—The results of studies of the nature of corrosive attack on copper and copper alloys have been published in a 24-page booklet, No. B-36, "Corrosion Resistance of Copper and Copper Alloys." The chemical and physical nature of corrosive attack in its various forms is explained. Included is a tabulation indicating the relative corrosion resistance of the principal types of copper and copper-base alloys when in contact with 183 different corroding agents.

54 OIL BURNERS

Engineer Co.—New bulletin OB-PC describes wide range mechanical or steam-atomizing-type oil atomizers for all types of pulverized coal; gas or oil-burning air registers; and fuel-oil pumping and heating-unit systems.

55 O-RINGS

Linear, Inc.—Compact 6-page folder contains tables of standard O-ring sizes as well as dimensional data for installation. Notes give general recommendations on clearances, design, material, machining, and finishes for most O-ring applications. A special compound bulletin containing descriptions of the latest polymers and synthetic rubbers from which O-rings can be molded is also included.

56 TECHNICAL BOOKS

John Wiley & Sons—Publishers of scientific and technical books. 1951 Catalog available, containing descriptions of over 1300 books in science and engineering. Of particular interest to engineers are the following recently published Wiley titles: Crede's "Vibration and Shock Isolation," Hetenyi's "Handbook of Experimental Stress Analysis," Gillett's "The Behavior of Engineering Metals," Salisbury's "Steam Turbines and Their Cycles," Hrones' "Analysis of the Four Bar Linkage," Eckman's "Industrial Instrumentation," and Brown's "Unit Operations."

57 GRAPHITE PRODUCTS

Joseph Dixon Crucible Co.—A 23-page booklet contains data on the history, sources of supply, characteristics of various graphites, specific properties, recommendations for the selection of the best-suited graphite for a particular requirement, and general information about products made from or with natural graphite.

58 STEAM TRAP BOOK

Armstrong Machine Works—Catalog J, a completely new 44-page combination catalog and steam-trap manual, gives details of trap operation, construction, selection, installation, and maintenance. Contains charts, tables, and safety-factor data for trap selection.

59 WATER CONDITIONING

Permutit Co.—Mixed Bed Demineralizer booklet No. 3591 describes the operation, states advantages, and suggests when this type of unit should be used. Unit delivers "Conductivity Water," total electrolytes less than 0.5 ppm and silica below 0.1 ppm.

60 CONDENSATE RETURN UNITS

American Hydrovac, Div. of Pitz Foundry Inc.—Bulletin 200AA-400 describes two distinct designs for single or duplex condensate return units for ratings from 2000 EDR to 100,000 EDR and working pressures to 60 psi with lifetime cast-iron receivers.

61 COPPER AND COPPER ALLOYS

Revere Copper and Brass, Inc.—Booklet contains complete technical data on all leading Revere alloys. It includes material on coppers, brasses, bronze alloys, nickel alloys, manufactured forms, aluminum products, welded steel tube, lockseam tube, welding techniques, and a condensed list of products.

62 MARKING TOOLS

M. E. Cunningham Co.—Bulletin J-547 describes the Cunningham line of "Safety" marking tools. It illustrates the standard line of marking devices and includes symbol charts and special codes.

63 BALL BEARINGS

New Departure, Div., of General Motors—Supplementing its standard catalog, a series of five books, helpful to the engineer and designer in applying ball bearings to any new machine. The first book deals with principal bearing types and fundamentals of mounting practice; the second, details of shaft and housing designs; and the third, enclosure and lubrication for varying operating conditions; the fourth book gives a new simplified method of computing bearing loads; while the fifth entitled, "Application Procedure," outlines the necessary steps in obtaining assured bearing performance.

64 PRESSURE VESSELS, ANNEALING COVERS AND GALVANIZING KETTLES

National Annealing Box Co.—A 28-page catalog on pressure vessels, annealing covers, and galvanizing kettles contains a picture tour of National's modern plant. This booklet also includes technical data and photographs of a variety of products for the steel, chemical processing, and petroleum industries. Among the equipment illustrated are bubble towers, fermenters, tanks, stripping columns, sterilizer tanks, stainless-steel stacks, and catalyst storage hoppers.

65 THERMOSTATIC STEAM TRAPS

Sarco Co.—Stainless-steel and monel elements for pressures to 300 psi and for corrosive condensate are a feature of the new line of Sarco thermostatic steam traps. Condensate and air venting capacities of all traps are practically doubled, through a new design which permits traps to reach rated capacities with a drop from steam temperature of only 10 F. New bulletin 250-A.

66 CHEMICAL PROCESSING EQUIPMENT

Struthers Wells Corp.—A 20-page catalog of chemical processing equipment illustrates and describes dryers, kilns, heat exchangers, evaporators, fired heaters, high-temperature heating equipment, Krystal crystallization equipment, mixers and kneading machines, quick opening doors, and propeller agitators. Over 75 photographs of finished products and production equipment are included.

67 DIRECT, POSITIVE COPIES

Charles Bruning Co.—"How to Duplicate Anything Drawn, Written, Typed or Printed" is a 48-page brochure answering questions on the Bruning copying process. This interesting booklet describes the various uses and low cost of prints. Several case histories in various fields of industry illustrate the versatility of the clean and odorless process.

68 BULK MATERIALS BIN-FLO AERATOR UNIT

Bin-Dicator Co.—4-page bulletin BF-1 with enclosures gives complete description and illustrations of unit; application data, typical layouts, air pressure, consumption, supply and piping data, specifications, prices and installation instructions, and list of present users in 23 states. Simple low-cost device provides uniform and continuous flow of dry, finely ground materials from bins, hoppers, and chutes.

69 DRAWING PENCIL

Eagle Pencil Co.—Sample of new improved Turquoise drawing pencil made with 100 per cent electronic graphite is offered. Laboratory tests show it to be smoother, longer-wearing, blacker, more opaque, and capable of holding a fine needle point without crumbling. Specify degree desired.

70 CONDENSIFILTER

Hankison Corp.—Hankison model B-30 Condensifilter, which removes water and oil from compressed air used to operate instruments, is described in a new two-page bulletin. Measuring only 15 in. high × 9 in. in diam, this compact unit removes water by condensing the air through passing it over a series of cooling copper coils, then removes oil, sludge, and other foreign material by passing the compressed air through a filter cartridge consisting of five hexagonal chambers in parallel. Self-purging trap automatically discharges the condensate.

71 WATER CONDITIONING

Permutit Co.—Latest Development—Effluent from Hot Lime Soda Softener Reduced to Zero Hardness by Permutit Hot Zeolite Process No. 3507. The hot zeolite process which replaced second-stage phosphate treatment is described and illustrated.

72 INDUSTRIAL LUBRICANTS

Brooks Oil Co.—Commemorating its 75th Anniversary the Brooks Oil Co. has published a 24-page brochure which includes technical data on industrial lubricants and historical information about the company. Over 24 case histories are cited which indicate how Brooks lead-based lubricants have compared with other products on such applications as open and enclosed gears, corrosion protection, rolling mills, circulating systems, bearings, leaking gear cases, railroad switch-plates and track curves, gear reductions, and wire-drawing machinery.

73 ROLLER BEARINGS

Shafer Bearing Co.—Engineers and specifiers of industrial roller bearings and mounted units will be interested in 56-page catalog 51. Illustrates and

describes full line of roller bearing units plus unmounted roller bearings. Design features such as concave rollers operating between matched convex races, and the advantages of this design are fully discussed. Of interest are larger models of bearing units with standard shaft sizes now available up to 5-in. diam. Also contains complete engineering and load rating data and illustrates many product applications.

74 GEARS

Stroh Process Steel Co.—Cast steel "Wear-Proof" gears are described. Made by the unique Stroh Process, these gears have wearing surfaces of hard alloy steel to resist the most severe metal-to-metal or abrasive wear. The body of the gears are of low-cost carbon steel.

75 ANACONDA COPPER AND COPPER ALLOYS

American Brass Co.—New edition of Anaconda Data Book contains 138 pages of tabulated weights and standard dimensions of copper and brass mill products, as well as compositions, physical constants, and properties of copper alloys. Miscellaneous data tables include conversions, comparisons of standard gages, capacities of tanks, dimensions of circles and squares, and mathematical rules and formulas.

76 LIFTING JACKS

Duff-Norton Mfg. Co.—The world's largest and most complete line of lifting jacks is described and illustrated in catalog No. 203. This 40-page book includes technical data, performance details, significant dimensions, weight, and price of a great variety of jacks ranging in size from 3 to 100 tons. Ratchet jacks, in trip-lowering and ratchet-lowering models; screw jacks in geared and plain screw models, air motor power jacks and hydraulic jacks are included.

77 SPRAYING NOZZLES

Spraying Systems Co.—30-page catalog No. 22 lists hundreds of nozzles in tabular form to exactly meet requirements for aerating, air conditioning, chemical and metal processing, water cooling, aggregate washing, spray drying, descaling, cooling towers, condensers, spray ponds, etc. Gives spray characteristics, construction, materials, liquids sprayed, impact, use recommendations, sizes, pressures, capacities, and dimensions.

78 NEW SOLVENT

Haas Miller Corp.—Immunol, added to water immunizes it against rusting ferrous metals, is described in a new brochure. In addition it imparts unusual detergent properties and complete "wetting out" action. Immunol solutions are odorless and neutral, contain no soaps or alkalies, are non-inflammable and will not affect the skin. Replaces alkali cleaners and inflammable solvents.

79 SPREADER STOKERS

Hoffman Combustion Engineering Co.—Catalog No. 51-CAD describes and illustrates features of moving-grate spreader stokers. Catalog 51-PDG describes, illustrates, and supplies additional information on spreader stokers with dumping grates. Capacities from 20,000 to 250,000 lb of steam per hr.

80 WORM GEAR SPEED REDUCERS

D. O. James Gear Mfg. Co.—Current 8-page illustrated catalog No. 45-C containing valuable informative engineering data and prices on single and double worm gear reducers. Type "S" or single reduction comes in 24 sizes, in ratio ranges of 5.66:1 to 100:1 and from .04 to 15 horse-power. Double worm gear reducers are available in 10 sizes with ratio ranges of 87:1 to 10,000:1 and from 106 in-lb to 3480 in-lb output torque. Stock sizes, available for immediate shipment, are plainly indicated.

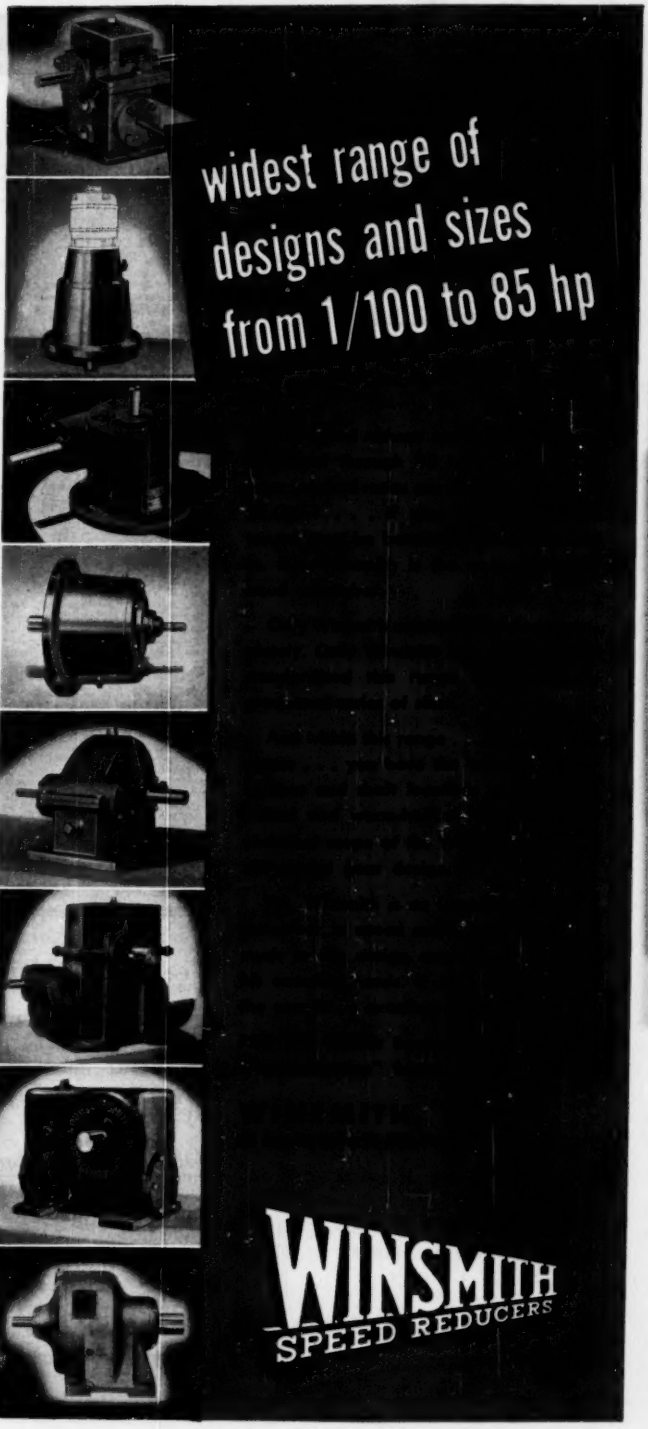
81 TEFLON GASKETS

Flexitallic Gasket Co.—Folder gives properties, applications, construction features, and advantages of Flexitallic spiral-wound gaskets filled with Teflon. Illustrates how Teflon is trapped between edges of metal to prevent cold-flow after bolting load is applied. Shows how the flexibility of the gasket structure assures safe efficient sealing, prevents leakage and contamination, and eliminates the necessity of frequent gasket replacement.

82 VIBRATION CONTROL

MB Mfg. Co.—Products for the detection, reproduction, and isolation of vibration are described in bulletin 410. Booklet contains helpful design data on vibration control, plus information on Isomode pad, Isomode units, and details on MB vibration exciters and test equipment

Continued on Page 50



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ME-11 HS II

83 SELF-CONTAINED BOILERS

Cleaver-Brooks Co.—New boiler catalog No. AD-100 completely describes the self-contained LR boilers for heating and processing. Lists features, shows typical applications, covers design, construction, efficiency, and contains charts on capacities and dimensions. The back cover is devoted to engineering service and a complete list of sales representatives handling and servicing Cleaver-Brooks self-contained boilers.

84 BOILER FEEDWATER CONTROL

Republic Flow Meters Co.—New bulletin No. S-52, describing and fully illustrating the one, two, and three-element boiler feedwater control system. A comparison of the three systems and the advantages of each are featured in this 8-page brochure.

85 FILM-TYPE HEAT EXCHANGERS

Henry Vogt Machine Co.—Bulletin HE-7 describes the design and applications of a vertical, single-pass heat exchanger. Cooling water falls in a film on the inside surfaces of the tubes. Uses dirty water and units can be cleaned in operation.

86 SPREADER STOKERS

Detroit Stoker Co.—Bulletin No. 80 describes improved-type spreader stoker, having a forward moving grate that slowly and continuously discharges ash at front. Has uniform fuel distribution, high burning rates, and burns all grades of bituminous coal or lignite, wood, and refuse. Thermal efficiency is exceptionally high—either with steady or fluctuating loads.

87 AUTOMATIC BURNERS

Peabody Engineering Corp.—The Peabody automatic burner unit is described in a new bulletin. Developed for pumping, heating, and burning heavy fuel oil it employs the identical wide range mechanical, pressure-atomizing method used exclusively in the nation's largest power plants. At such installations, economies are calculated in fractions of a percentage point.

88 ADJUSTABLE FLOW REGULATORS

Waterman Engineering Co.—An adjustable flow regulator for cylinder speed control is described. This adjustable regulator gives a constant rate of flow regardless of pressure fluctuations or change in work resistance at any setting within the adjustable range. Adjustable range is 50 per cent of the calibrated flow rate in gpm. It is available for hydraulic systems with operating pressures to 3000 psi. Line sizes are $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, and $\frac{3}{4}$ in. NPT (dry seal). Maximum controlled flow is 16 gpm.

89 BALL AND ROLLER BEARINGS

Aetna Ball and Roller Bearing Co.—Latest 52-page catalog gives specifications on Aetna's full line of standard ball thrust bearings, clutch release bearings, ball retainers, and hardened and ground washers. Contains technical data for design engineers, useful calculations and formulas, important application principles, fundamentals of proper lubrication, bearing selection and care.

90 ROTARY OIL PUMPS

De Laval Steam Turbine Co.—The De Laval catalog L313A-B describes the new IMO series A313A pump. This is designed for pumping petroleum products and other light or viscous fluids, against medium pressures, as required for rotary and steam atomizing oil burners, oil transfer, lubrication, hydraulic systems and similar services. Capacities to 85 gpm—pressure 150 psi.

91 RADIAL-THRUST ROLLER BEARINGS

Shafer Bearing Corp.—Latest 56-page catalog gives complete specifications of Shafer ConCaVex radial-thrust roller bearings, featuring full capacity self-alignment within the bearing itself. Available in unmounted single and double-row style, or in double-row mounted units as follows: Pillow blocks, flange units, cartridge units, flange-cartridge units, duplex units, take-up units, take-up and frame units. Mounted units available in normal duty, standard heavy duty, and adapter mounting types as well as in "Specials."

92 FLEXIBLE, SWIVEL, SWING, AND REVOLVING BALL JOINTS

Barco Mfg. Co.—For piping and lines conveying steam, oil, air, gasoline, water, chemicals, including corrosive acids and alkalis, and other fluids or gases. Types for pressures up to 750 psi, steam, and 6000 psi hydraulic. Complete range of sizes. Catalogs No. 215 "Flexible Ball Joints"; No. 265 "Rotary Swivel Joints"; No. 400 "Barco Swing Joints"; No. 300 "Revolving Joints."

93 STEAM JET AIR EJECTORS

Condenser Service and Engineering Co.—Bulletin No. 103, describes steam jet air ejector equipment for steam condensers, process equipment, evaporators, and evacuation work. Theory of operation explained with illustrations of various types of units. Full engineering information given with drawings and charts. Discussion of operation and auxiliaries.

94 FELTS

American Felt Co.—Special SAE folder contains technical data and specifications of the various felts made to SAE standards. The folder includes illustrative samples.

95 PHOTOELASTIC STRESS ANALYSIS

General Radio Co.—New folder on a lightweight polariscope having an 8-in. field gives details on static and dynamic stress measurements for both visual and photographic applications, including dynamic measurements with a high-speed light source.

Read the various items listed . . . one catalog may hold the solution to your present problem . . . and select those of interest to you. *Distribution by us to students is not included.* The coupon on page 42 must be mailed on or before December 15th in U. S., December 24th elsewhere.

96 THERMOSTATS

Fenwal, Inc.—Catalog on unique Thermoswitch* heat control, a precision thermostat having outstanding advantages of instant response, high accuracy, wide range, rugged construction and ease of installation. Catalog describes wide application and gives full engineering details, and shows how Thermoswitch unit can often replace expensive control instruments. (*Reg. U. S. Pat. Off.)

97 SPREADER STOKERS

Detroit Stoker Co.—Bulletin No. 890 describes a spreader stoker having overthrow rotors that provide exceptionally uniform fuel distribution. Available with stationary, hand-dumping, and power dumping grates. Many sizes assure efficient application to all types of boilers and steam generators. Burns all grades of bituminous coal, lignite, and various kinds of wood, and other refuse.

98 COOLING TOWER EQUIPMENT

J. F. Pritchard & Co.—Complete line of specialized equipment is covered by latest illustrated catalog No. 1.19.902A. In addition to describing medium and large mechanical draft cooling towers, atmospheric types, and small packaged models, catalog provides information on cooling-tower nozzles, fans, fan drives, air and gas-treating equipment, and air-cooled heat exchangers.

99 OIL SEALS

Johns-Manville—Clipper Seal brochure describes complete story of this precision-molded oil seal that provides efficient bearing protection at low cost. Includes photographs and diagrams of typical installations; shows how various lip designs provide choice of bearing surfaces; how its simple one-piece construction allows greater freedom in designing oil-seal cavities.

100 AUTOMATIC SCALES

Richardson Scale Co.—Bulletin No. 0450 presents basic specifications of conventional Richardson automatic scales for materials-handling-by-weight. Over 200 materials (liquid and solid) are listed alphabetically, with information on the Richardson scale recommended for standard industrial applications.

101 STEAM AND LIQUID CONTROL EQUIPMENT

O. C. Keckley Co.—Catalog No. 51, contains 56 pages of illustrations and engineering data on precision pressure regulators, temperature regulators, float valves, water gages, float boxes, safety and relief valves, strainers, etc. Drawings, layout diagrams, dimensions, and capacity tables are included.

102 DRAWING PENCILS

A. W. Faber-Castell Pencil Co., Inc.—Sample of any degree of Castell you desire complimentary is the best way to prove the established superiority of this superb drawing pencil. Positive accurately graded leads and greater blueprint reproductivity will be proved to you by actual tests.

103 COPPER AND COPPER ALLOY SPECIFICATIONS INDEX

American Brass Co.—The first edition of this index, published 2 years ago, and the 1949 edition, were extremely well received by thousands of men in the metal-working field.

104 ELECTRICAL MACHINERY

Fairbanks, Morse & Co.—Bulletin E100H, "Catechism of Electrical Machinery," presents the most important theoretical and practical features of common types of direct-current and alternating-current motors, generators, and control equipment. Intended for those who are not familiar with electrical phenomena or terminology. The text is illustrated with Fairbanks-Morse machinery, and in some cases the details of these machines are discussed.

105 AIRCRAFT CONTROL BEARINGS

Shafer Bearing Corp.—Fully illustrated catalog devoted exclusively to the Shafer line of aircraft roller bearings which are available in a full-size range of standard (specials to order) self-contained, single-row, double-row, and rod-end types for all conventional control applications for all types of air-borne craft. Contains complete specifications, engineering and application data and relative merits of the basic Shafer ConCaVex design which employs concave rollers and convex races.

106 NEW INSTRUMENT VALVES

Edward Valves, Inc.—New bulletin No. 491 providing information on the new drop-forged steel

Continued on Page 52

S.S.White

FLEXIBLE SHAFTS
retain their smooth operating characteristics!

Here's what Barber-Colman Company of Rockford, Illinois, says about the S.S.White flexible shaft used in their Remote Adjustable Thermostat unit shown above:

"Test results indicate that the operation of the S.S.White remote control flexible shaft is satisfactory at temperatures ranging from −65°F. to +160°F. There is virtually no measurable variation in torque required to turn the shaft, or in torsional deflection required to initiate cam movement over the temperature range."

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more horse-power per pound

Famous for stamina and a sure foot, the burro was a hard-working "pardner" of the old-time prospector. He's a little fellow—but he packs more horse-power per pound than any of his four-footed cousins . . .

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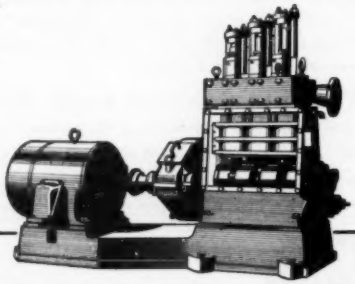
Applications where you'll find Aldrich Direct Flow Pumps putting in time and over-time include: hydraulic systems for press operation; plastic and rubber molding and extrusion; steel mill descaling, and other uses in the petroleum and chemical industries. Write today for Data Sheets 64, 64B.



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Representatives: Birmingham • Bolivar, N. Y. • Boston • Buffalo • Chicago • Cincinnati Cleveland • Denver • Detroit • Duluth • Houston • Jacksonville • Los Angeles • New York Omaha • Philadelphia • Pittsburgh • Portland, Ore. • Richmond, Va. • St. Louis • San Francisco Seattle • Spokane, Wash. • Syracuse • Tulsa • Export Dept.: 751 Drexel Building, Phila. 6, Pa

Edward instrument valves for meter, gage, instrument, and other small lines. These new valves have a rating of 6000 lb WOG at 100 F or 1500 lb sp at 1000 F. Bulletin contains dimensions, weights, prices, and operating data.

107 POWER PRODUCTS DIRECTORY

Allis-Chalmers Mfg. Co.—This 40-page directory, 25B6057, lists the more than 1600 Allis-Chalmers products made for power generation, power distribucion, and power utilization together with engineering literature available on a wide range of equipment for the farm, mine, industry, and utility.

108 FAFNIR FLANGETTE

Fafnir Bearing Co.—6-page Folder describes a complete power transmission unit, incorporating a Fafnir wide inner ring ball bearing, and self-locking collar. Housings are interchangeable steel flanges with inside surfaces matching bearing outer ring, thus providing initial self-alignment in all directions. Folder carries photos, installation instructions, sizes, and load ratings.

109 ROLLER CHAINS

Whitney Chain Co.—New 72-page Catalog RCE-50R shows how roller-chain drives can be applied to a wide range of production equipment to step up output and reduce costs. Comprehensive contents include application photographs, chain illustrations, dimensions, and tables. Complete engineering data is arranged to simplify selection of the proper chain drive for any application.

110 UNFIRED PRESSURE VESSELS

Downingtown Iron Works—A partial analysis of the 1950 ASME Code for Unfired Pressure Vessels compared with the 1949 Code has been prepared by the Downingtown Iron Works. In addition to the comparison there are data on the facilities and manufacturing equipment and the welding procedure qualifications of the Downingtown organization.

111 IRON CEMENTS

Smooth-On Manufacturing Co.—40-page, pocket size Smooth-On Repair Handbook describes practical, time-saving, money-saving repairs made on plant shop, factory, garage, and home equipment with Smooth-On iron cements. Leaks stopped, cracks sealed, loose parts, and fixtures tightened. More than a million copies of this popular Manual have already been sent out in response to requests. Contains 170 diagrams. Clear tested directions.

112 BOILER-WATER COLUMNS

Reliance Gauge Column Co.—New bulletin No. 516 describes boiler-water columns and gage equipment such as the original "alarm" water columns, remote reading water-level gage, liquid-level alarms, illumination equipment, gage valves, gage cocks, etc.

113 BRONZE CASTING ALLOYS

American Manganese Bronze Co.—50-page edition of the "Reference Book on Bronze Casting Alloys" gives general information on composition, characteristics, and applications of many of the common or typical alloys. The book will help the engineer or designer in the selection of the right alloys for any general application.

114 VALVES

Ledeen Mfg. Co.—Recent bulletin No. 510 describes a line of hand-operated, foot-operated, and finger or solenoid-operated valves for controlling the flow of air, oil, or water. Bulletin shows circuit diagrams and operation detail, dimensions and weights, and descriptions of 14 models which are available in 6 sizes for 5 different cycles.

115 GENERAL PURPOSE PUMPS

Economy Pumps, Inc.—New line of general purpose pumps, type SCC, are described in catalog No. D-851. Pumps are suitable for small cooling-tower or air-conditioning system, water circulation, domestic water supply, hot water heating system circulation, booster pumping, process pumping, etc. Catalog gives applications, descriptions, construction details, performance curves, and list prices.

116 CRUSHERS

American Pulverizer Co.—Bulletin illustrates and describes in detail complete line of custom-built crushers, grinders, shredders, and choppers for uniform reduction. Includes cutaway and cross-sectional views as well as engineering data and specifications.

117 CONSTANT DELIVERY PUMPS

Oilgear Co.—New 4-page bulletin No. 46601 illustrates and describes three new constant delivery axial piston pumps for pressures up to 3000 and 5000

psi. These units incorporate balanced flat valves (port plates), simple one-piece rolling pistons, and reverse-flow high-pressure and supercharging pressure relief valves.

118 GENERAL PURPOSE TURBINES

Westinghouse Electric Corp.—Booklet No. B-3896. The type-E turbine will perform a number of jobs well even under abnormal operating conditions. Designed for economy and dependability in continuous or stand-by operation. An excellent means of effecting steam expansion without loss of energy. Fully illustrated and diagramed.

119 BLAST CLEANING AND DUST CONTROL

Pangborn Corp.—The latest developments in blast cleaning or dust control in Bulletin 1200 Pangborn's "Condensed Catalog." This illustrated bulletin tells the full story of air and airless blast cleaning, hydro-sand blast, hydro-finish, wet sand blast, accessories, and dust control.

120 HERMETICALLY SEALED RELAYS

Guardian Electric Mfg. Co.—Hermetically Sealed Relay Catalog 5-H contains ten pages of photographs and specifications; application, operating, and contact data; diagrams and other information on various types and designs of hermetically sealed relays.

121 FLY-ASH COLLECTION

Research Corp.—Bulletin No. FA, entitled "What's New in Fly Ash Collection," discusses problem, particle-size analysis, efficiencies, new developments, and engineering features of Research Corp. electrical precipitators for this service. Continuous rapping and automatic voltage control equipment described.

122 RECIPROCATING AIR SANDER

Detroit Surfacing Machine Co.—Descriptive literature describing newly developed, lightweight, comfortable grip, reciprocating air sander with straight-line action which duplicates natural, hand-block finishing. Practically vibration-free, does not cut abrasive patterns, operating speed maintained with 70 lb air pressure.

123 SPEED REDUCERS

Cone-Drive Gears, Div. of Michigan Tool Co.—Condensed Catalog, Bulletin 8901-50, of standard double-enveloping gear speed reducers, covering some 190,000 combinations of sizes, ratios, and types (all available from stock) into a single 8-page bulletin. The bulletin contains complete information on ratings of all sizes and types, dimensional drawings and specifications, features, how-to-order information, etc.

124 CENTRALIZED LUBRICATION

Farval Corp.—Bulletin No. 25 provides a complete explanation of the Farval Dualine system of centralized lubrication and its advantages as a means of saving oiling labor, lubricant, bearing expense, and production time for various types of heavy industrial equipment. Its 16 pages liberally illustrated with photographs, drawings, and diagrams.

125 THERMOSTATIC BIMETAL

W. M. Chace Co.—64-page reference manual to aid engineers in design of actuating elements for temperature-responsive devices. Contains applications of Chace thermostatic bimetal, elements of thermostat design, proper heat treatment for bimetal, various formulas and calculations, descriptions of 30 bimetals with 30 full-page charts and data describing physical properties of each bimetal.

126 CENTRAFIRE STOKER

Westinghouse Electric Corp.—Booklet No. B-3890-A. The Westinghouse link grate combined with the centrafire principal gives controlled distribution of air and coal over entire combustion area. This unit will fire any grade coal, create optimum burning, and discharge ash without interrupting coal feed or reducing capacity. Fully illustrated and diagramed.

127 FEEDWATER REGULATORS

Northern Equipment Div.—Continental Foundry & Machine Co.—New Bulletin No. 491 concisely describes and tabulates engineering data for COPES simple-level, flowmatic, and balanced flow feedwater controls; also for differential, pump governor, pressure reducing, and balanced valves, also for desuperheaters, liquid level controls, and hi-lo water alarms. List of representatives in U.S.A. and Canada included.

128 HORIZONTAL END SUCTION PUMPS

Peerless Pump Div.—Food Machinery & Chemical Corp.—Bulletin B-2300 describes complete line of horizontal end suction general-purpose pumps available in close-coupled electric and belted models. Handle capacities up to 5500 gpm and heads to 260 ft. Motor sizes are available from 1/4 to 150 hp. Compact, efficient, durable, and versatile pumps for water and alkaline fluids.

129 OPEN STEEL FLOORING

Open Steel Flooring Institute, Inc.—New 16-page idea-book, "Versatile—Open Steel Flooring," is illustrated with installation photographs showing the many and varied possibilities for using steel grating. It explains types and features of open steel flooring and specifications for insuring quality open steel flooring and its proper installation.

130 AIR PREHEATERS

Air Preheater Corp.—First section of Catalog on Ljungstrom Air Preheaters presents an over-all picture of the Ljungstrom, its functions, and operation. Examples of installations of the Ljungstrom continuous counterflow regenerative-type preheater, covering a range of diverse applications, are shown in diagrammatic form, together with photographs of the Ljungstrom in sufficient detail to make its principle and operation clear.

131 SOOT BLOWERS

Vulcan Soot Blower Div.—Continental Foundry & Machine Co.—New bulletin No. 493 offers in condensed form, pertinent data on modern automatic-sequential soot blowing systems, including control panels and descriptions of air or electrically operated rotary long and short retractable units and manually operated units. Many construction details are shown and a complete list of representatives for U.S.A. and Canada is included.

132 RIGHT-ANGLE VERTICAL-PUMP DRIVES

Western Gear Works—Bulletin 4907 describes the Pacific Western line of right-angle vertical-pump

Continued on Page 54

Ideas for Engineers
INDUSTRIAL PRODUCTS DIVISION
WESTINGHOUSE
AIR BRAKE COMPANY
WILMERDING PENNA.
Datair Sheet
#5
EQUIPMENT: Cooling Water Sump Control
To Supply
H-3 Controlair Valve
Steam
Throttle
A-2-H
Sump Actuator
Float
Steam Pump
APPLICATION: To proportion flow of recirculated cooling water to processing load
SOLUTION: Westinghouse H-3 controlair linked to float in sump. Movement of float varies delivered air pressure from valve to Westinghouse A-2-H Actuator, which positions itself accordingly, adjusting steam pump throttle
RESULT: Elimination of manual control-adequate cooling water under all rates of plant operation

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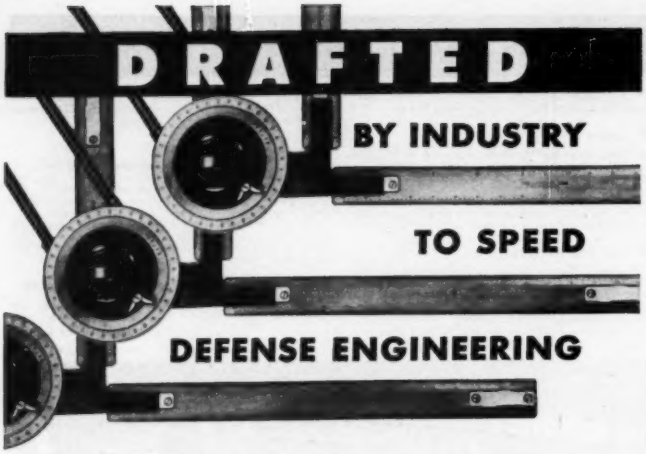

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drives which cover a wide range of power and speed requirements, including all sizes larger than 200 hp at 1:1 ratio and 720 rpm. They are designed for 24 hr a day continuous duty in pumping service for the specific application of horizontal-type prime movers to vertical shaft pumps.

133 COIL SPRINGS, WIRE FORMS, AND METAL STAMPINGS

Dudek & Bock—Bulletin shows how the manufacturer's free design service can save users many dollars. Learn of the special instruments developed to take the guesswork out of specifying, inspecting, and testing. Includes valuable engineering charts and data in easy-to-understand language.

134 TRACING PENCIL TEST KIT

American Lead Pencil Co.—Kit contains samples of Venus tracing pencils for testing on various types of papers. This new pencil contains an active chemical to produce clearer, sharper, white or blueprints when reproduction is made from a pencil drawing.

135 SPREADER STOKERS

Blower-Stoker Div.—Read Standard Corp.—Bulletin No. 85 describes the application and construction features of the Chicago automatic spreader stoker which is designed to distribute any grade of coal most effectively over the entire grate area and meet all firing requirements. Detail photographs and cross-sectional drawings illustrate features of the improved stoker.

136 MECHANICAL SPRINGS

Associated Spring Corp.—"The Mainspring," periodical of current thinking on spring-design news and applications. Semitechnical short articles in easy-to-follow style, with humorous illustrations. Covers all types of springs and other pertinent data. Issued every two months. Subscription free upon request.

137 VERTICAL CENTRIFUGAL PUMPS

Lawrence Pump & Engine Co.—"Vortex"—not just a sump pump! Whenever your industrial pumping problem concerns a vertical unit, either dry pit or wet well installation, consult "Vortex" engineers for your best answer. Write for October, 1951, bulletin on "Vortex" Vertical Pumps.

138 CLUTCHES AND POWER TAKE-OFFS

Rockford Clutch Div., Borg-Warner Corp.—Bulletin on power transmission control shows typical installation of Rockford clutches and power take-offs. Contains diagrams of unique applications. Furnishes capacity tables, dimensions, and complete specifications. Every production engineer will find help in this handy bulletin when planning his new products.

139 RECIRCULATION STEAM GENERATORS

Combustion Engineering-Superheater, Inc.—A new bulletin featuring the C-E Recirculation steam generator. Either oil or gas-fired, a complete steam plant with fuel, air and water all co-ordinated automatically under push-button control. Most compact of all currently available so-called "Package" boilers the C-E recirculation steam generator is available in steam capacities ranging from 2800 to 6000 lb of steam per hr.

140 PRESSURE GAGES

Helicoid Gage Div., American Chain & Cable Co.—New 16-page Helicoid gage catalog. The Helicoid gage is the only pressure gage with the Helicoid movement. It is guaranteed accurate to within $^1/_2$ of 1 per cent of the total dial graduation over the upper 95 per cent of the 280-deg dial arc. This means that on a 100-lb dial for example, accuracy is guaranteed to within $^1/_2$ lb over the entire scale except from 0 to 5 lb. Cutaway photographs and line drawings show the complete line of Helicoid gages.

141 REVOLVING UNIT HEATERS

L. J. Wing Mfg. Co.—Bulletin HR-6 is the latest revised edition of a 16-page bulletin, illustrated with many new photographs of installations. Describes and illustrates ceiling-suspended, downward discharge unit heaters with revolving discharge outlets that distribute the heated air in slowly moving streams that reach into far corners, around machinery and obstructions, avoiding hot blasts and cold spots, and giving sensation of fresh, live, invigorating warmth to workers. Engineering data and installation details.

142 PUMPS

Aurora Pump Co.—Condensed Catalog M, embodying illustrations, suggested uses, specifications, and condensed selection tables for Aurora centrifugal and Apco turbine-type pumps and water systems.

143 FLOATING ROOF TANKS

Graver Tank & Mfg. Co., Inc.—New 12-page booklet describes the operating features of Graver's new design for single-deck floating roof tanks for the vapor-saving storage of gasolines and for corrosion-resistant storage of crudes. Technical data and developmental studies are included.

144 MECHANICAL SPRINGS—THEIR ENGINEERING AND DESIGN

Associated Spring Corp.—64-page handbook of design information and engineering charts and formulas, covering all types of springs, snap rings, and spring washers. Includes tables of physical properties of spring materials, weights of flat steel and round wire, steel hardness numbers, etc. Special sections on motor springs, hairsprings, hot-wound springs, and Belleville springs.

145 PURIFIERS

V. D. Anderson Co.—Bulletin No. 100 announces the internal type Anderson HI-eF purifier for high-efficiency separation, guaranteed to deliver vapor with 1.0 ppm or less of total solids. The Anderson purifier (scrubber) offers highest efficiency in removing entrainment for steam drums, flash tanks, evaporators, packed towers, bubble-cap towers, deodorizers, and stills.

146 UNIT HEATERS

Grinnell Co.—Catalog UH-1950 illustrates and describes horizontal and vertical delivery and textile types of Grinnell Thermoliers. Textile-type self-cleaning for use in dusty, lint, and fly-laden atmospheres. Complete capacities, dimensions, weights, motors, wiring diagrams, piping connections, and methods of suspension. Exclusive features described and illustrated.

147 WELDING

American Welding & Mfg. Co.—Bulletin CA-50 discusses fabrication by controlled technique flash-butt welding. Illustrated are a variety of welded rings and bands and weldments. The bulletin discusses research engineering, fabrication technique, scientific inspection, and precision machining with many successful welding problems.

148 AXIAL-FLOW FANS

Aerovent Fan Co.—11th Edition catalog describes Aerovent "Macheta" axial-flow exhaust and ventilation, 9 to 144-in. direct-connected, belted, extended shaft, mancooler, pulley, duct and belted-duct fans.

149 EXTRUDED ALUMINUM

Aluminum Company of America—Booklet contains a discussion of design and production advantages of aluminum extrusions. Illustrations of the way several extruded shapes can be combined to simplify assembly and reduce costs. Data on size and shape limitations, alloys, section thickness, tolerances, die costs.

150 DRAFTING ROOM EQUIPMENT

Hamilton Manufacturing Co.—Drafting equipment is described in Hamilton catalog No. 13-S. Auto-Shift tables with instant adjustment for height and slant from horizontal to vertical; tracing files with patented tracing lifter, making every sheet a top sheet; and a complete line of files and drawing tables to meet all requirements.

151 BEARING BRONZE

Bearium Metals Corp.—4-page stock list shows weights of over 750 sizes cored and solid bearing bronze bars up to 10 in. OD. Includes information on highly superior frictional properties found in bearium metal—a bronze devised primarily for bearings, bushings, and thrust washers.

152 CENTRIFUGAL PUMPS

Pacific Pumps, Inc.—Centrifugal Pumps from A to Z—Bulletin No. 1 is four-page publication, giving the temperature, capacity, pressure, and head range for 29 different types of horizontal and vertical centrigual pumps both single and multistage.

153 STOKERS

Flynn & Emrich Co.—Bulletin No. 1301 contains information and illustrations covering the F&E spreader stoker which incorporates in its design and construction all of the advanced engineering found in the spreader-type stoker of today. The electro-hydraulic drive, incremental hydraulic control valve, and alternate pusher coal feed are a few outstanding features. Bulletins 1105 and 1204 fully describe F&E underfeed stokers.

154 WORM GEAR SPEED REDUCER

Cleveland Worm and Gear Co.—Catalog 300A describes and illustrates Speedaire, the fan-cooled worm-gear speed reducer. Because of fan cooling, Speedaire delivers up to double the horsepower of a conventional drive. Its use saves weight, floor space, headroom, and initial cost—often as much as 50%. Dimensional and horsepower rating tables included.

155 STEAM BOILERS

Wickes Boiler Co.—Bulletins No. 44-1-2-3-4, 46-2, 48-1, 48-2, and 49-1 describe water-tube boilers of the 2-, 3-, and 4-drum design for direct firing by means of oil, pulverized coal, or stokers; also waste-heat units, Dowtherm, and package-type water-tube boilers; Dowtherm vaporizers; and steam generators. Boilers are built for pressures up to 850 psi and capacities to 250,000 lb of steam per hr.

156 AIR-POWERED SCREW DRIVERS

Ingersoll-Rand Co.—An 8-page folder describes how air-powered screw drivers can lower production costs, save assembly time, reduce spoilage and lower operator fatigue. Includes 4 pages on how to select the proper bits.

157 STEEL FLOORING AND ARMORING

Dravo Corp.—Machinery Div.—Catalog No. 1103 describes various types of open-steel flooring and armoring and discusses different types of Tri-Lok open-steel flooring and safety treads. Specification data, safe-load tables, installation methods, and other pertinent information, are included.

158 AIR-COOLED ENGINES

Wisconsin Motor Corp.—New and well-illustrated "Power Magic" brochure lists all of the heavy-duty

Continued on Page 66

The thin coating of cement, mechanically applied and troweled by the Centriline process, raises the pH of any moisture entrapped within the lining to a non-corrosive level—thus prohibiting *corrosion or tuberculation.* Centrilining also seals holes caused by external corrosion, increases the pipe's carrying capacity thereby reducing pumping and maintenance costs.

Over 1,000 feet of pipe a day can be Centrilined while *the pipe remains in the ground!* This process—utilizing centrifugal force in applying cement—will give new life to your old pipelines at a fraction of the cost of installing new pipes.

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Flexible ALL METAL COUPLINGS
FOR POWER TRANSMISSION REQUIRE NO MAINTENANCE

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Thomas Couplings have a wide range of speeds, horsepower and shaft sizes:
½ to 40,000 HP
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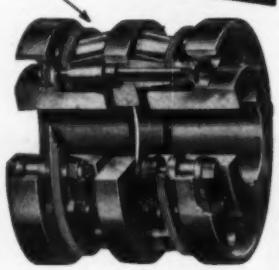

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features that have made Wisconsin engines predominant favorites on the farm, in the construction and industrial fields, on the railroads, in the oil fields, and in many other fields. Brochure also contains power curves and specifications on all models and world-wide list of distributors.

159 SPREADER STOKERS

Westinghouse Electric Corp.—Booklet No. B-4553 describes ideal firing equipment for capacities ranging from 50,000 lb of steam per hr to upwards of 350,000 lb per hr. Outstanding features of spreader-type firing are explained. Accurate control of fuel feed and distribution is made possible by use of unit hydraulic drive plus correct balance of primary and secondary air supply. Designed and built for severe continuous service.

160 CENTRIFUGAL PUMPS

Goulds Pumps, Inc.—Bulletin 710.1 describes centrifugal pumps available in 20 sizes with capacities up to 2000 gpm and heads up to 400 ft. The models are single stage, enclosed impeller type. Standardization of parts has been accomplished to the point where many wearing parts for one size are also used in several other units.

161 DOWTHERM VAPORIZERS

Union Iron Works—Union offers a helpful bulletin for users, or potential users, of Dowtherm "A" or "E." Tables of chemical and physical characteristics are included, as well as pertinent dimensions of several sizes of Dowtherm vaporizers. Union engineering, manufacturing, and installations service covers a wide range of sizes and types of Dowtherm systems.

162 LIQUID METERS

Buffalo Meter Co.—Niagara meter catalog bulletin No. 30 describes the simplest volumetric displacement meters for almost all liquids including cold water, hot water, petroleum products, oils, syrups, solvents, and many corrosive chemicals. Stainless steel meters have proved highly satisfactory for corrosive products. Registers are totalizing for continuous use, set back for batch measurement, or electri-contact type for automatic shut-off of liquid flow.

163 DROP FORGINGS

Drop Forging Association—"Metal Quality—Hot Working Improves the Properties of Metal," a 64-page booklet recently revised and issued by the Technical Committee, Drop Forging Association, for design engineers, metallurgists, and production-management executives, explains how hot-working improves metal quality. The text describes forging-quality steel and details of the various methods of forging. Check lists of the advantages obtained by use of forgings, economic benefits, are included.

164 PORTABLE DRAFT GAGES

Ellison Draft Gage Co.—Bulletin No. 109 describes inclined and vertical tube draft gages for field and laboratory work, for heating, ventilating, and air conditioning engineers. Constant zero. Level and tube replaceable in field. Also saturator gages for coke plants, steel mills.

165 METAL TURNINGS CRUSHERS

American Pulverizer Co.—Bulletin discusses value of crushed turnings in oil reclamation and scrap sale. Shows how to convert long metal turnings from a problem to a profit. Describes features, design, and construction of American crushers. Also lists approximate capacities, speeds, and power. Typical installations are shown.

166 FLY-ASH COLLECTORS

Fly Ash Arrestor Corp.—Bulletin described a low draft loss fly-ash collector designed for plants where draft is at a premium. Compact construction requires minimum space requirements. Installation is generally made in a breeching section.

167 BLOW-THRU MULTITHERM UNITS

Clarage Fan Co.—Bulletin No. 1310. Air-conditioning units equipped with Zone Control maintaining different temperatures and different humidities in various parts of a building. Each zone individually controlled. Zone Control compensates for differences in solar radiation, exposure, wind velocity, and varying internal loads.

168 PRESSURE AND TEMPERATURE REGULATORS

Spence Engineering Co., Inc.—A new 32-page booklet contains useful information about pilot-operated pressure and temperature regulators. Illustrated with photos, charts, and tables, it discusses main valves, controls, and strainers, gives capacity and flow data as well as dimensions and weights.

169 VIBRATORY MATERIALS HANDLING EQUIPMENT

Syntron Co.—Catalog No. 519, 44-pages, illustrates and describes complete line of equipment, including bin vibrators, vibratory feeders, weighing and batching feeders, long conveyers, shaft seals, and power tools.

170 FELT WICK LUBRICATORS

Miller Felpax Corp.—Catalog No. F-52 covers complete line of standard Felpax lubricators for railroad and industrial applications. Complete information on the care and maintenance of felt wick lubricators is included.

171 BLUEPRINT MARKING PENCIL TEST KIT

American Lead Pencil Co.—Kit contains samples of new Venus unique colored pencils for marking on blue or white prints. 54 per cent stronger—sharpens to a sharp needle point and holds it. 37 per cent greater markability—brilliant clear marking—waterproof.

172 AUTOMATIC CONVEYER WEIGHING

Merrick Scale Mfg. Co.—For automatic and continuous weighing on existing or new belt conveyers, bulletin No. 375 fully illustrates and describes the Weightometer. The Merrick Feedoweight for blending and proportioning material by weight is also available.

173 AXIAL FLOW BLOWERS

Blower-Stoker Div.—Read Standard Corp.—Publication No. 88 gives dimensional, capacity, and other engineering data on Standardaire low, medium, and high capacity blowers. Includes isometric drawing showing location of all blower accessories, also suggested applications and typical users.

174 FLEXIBLE COUPLINGS

Thomas Flexible Coupling Co.—The latest engineering information on Thomas Flexible Couplings is contained in their engineering catalog, which shows their complete lines of single and double types of all metal flexible couplings for heavy-duty impulse loads such as Diesel-driven compressors, as well as for smooth loads such as motor-driven centrifugal pumps.

175 COMPRESSOR CHECK VALVE

Pennsylvania Pump & Compressor Co.—Bulletin No. 509 features five distinct advantages provided by the installation of the PPC Aircheck valve in the discharge line of an air or gas compressor.

176 STRAIN MEASUREMENT

Hathaway Instrument Co.—4-page Catalog leaflet entitled "Dynamic Strain Analysis—General Considerations" outlines the elements necessary for a complete dynamic strain analysis laboratory and describes briefly strain gages, five types of strain-gage amplifiers for dynamic work, and eight types of oscillographs suitable for recording 6 to 24 records simultaneously and covering a frequency response range from zero or static to 50,000 cps, Hico 3-00-1.

177 LUBRICATION CHART

Hyster Co.—A 26-point lubrication chart, Form 1102, covers eight Hyster industrial truck models. Folding into a pocket-size handy reference, the chart numbers all service points of the eight models, tells when they should be serviced, and recommends certain types of oils and greases.

178 FEEDWATER CONTROL

Bailey Meter Co.—Bulletin No. 105-C describes latest developments in the Bailey three-element feedwater control. Bulletin discusses problems encountered in feedwater control and tells how the Bailey control system helps solve them. Diagrams, cutaway views, typical chart records, and installation photographs are included.

179 NICKEL ALLOYS

International Nickel Co., Inc.—Standard Alloys for Special Problems is an illustrated 16-page booklet that describes in detail the mechanical and other properties of nickel, Monel, and other Inco nickel alloys. It lists the mill forms in which these materials are produced as well as applications for which they are especially suited.

180 PACKAGED STEAM PLANT

Superior Combustion Industries, Inc.—Catalog No. 403 contains facts about Superior steam generators. Its 22 illustrated pages demonstrate the "how" and "why" of Superior steam generators' long-lived, high efficiencies. Easily-read tables provide engineers with essential data and dimensions.

181 HIGH-TEMPERATURE STEELS

U. S. Steel Subsidiaries—Catalog gives a detailed discussion, supplemented with photographs, drawings, charts, and tables, covering the properties and characteristics of steels in high-temperature service.

182 CONVEYER SYSTEMS

Allen-Sherman-Hoff Co.—Hydrovac catalog No. 448 describes the various methods developed for pneumatic materials handling and illustrates the special components involved. The automatic sequence head, which allows push-button control of the entire ash and dust-handling system, is also described in detail.

183 HYDRAULIC PUMPS AND CONTROLS

Denison Engineering Co.—New illustrated Bulletin No. 138 describes the Denison line of HydrOILic pumps, motors, 4-way valves, relief and sequence valves, and hydraulic pumping units for circuits for pressures up to 5000 psi. New surge damping control valve and pilot-operated solenoid control for preventing spool sticking is included.

184 HIGH-PRESSURE COMPRESSORS

Norwalk Co., Inc.—Catalog No. 40 describes high-pressure compressors of all types—from one to six stages up to 25,000 lb pressure—for all different types of gases. Also described are special compressors built to customer's specifications. A feature is a check list to save the customer's time when inquiring or ordering compressors.

185 HAND TRUCKS

Standard Pressed Steel Co.—Its new "Hallowell" Uni-Truk has unique, triple-welded angle construction of the nose, which eliminates danger of ends of side bars tearing loose. The Uni-Truk is inexpensive, lightweight, and well-balanced for nimble handling of all but the heaviest hand-truck jobs. Details contained in attractive, new illustrated Bulletin No. 789.

186 SINGLE RETORT STOKERS

Westinghouse Electric Corp.—Booklet No. B-2196-A. The wavelike motion of the Westinghouse link grate secures thorough permeation of the air in the fuel chamber and maintains higher combustion efficiency. Stoker drive may be either steam or electric. Either type of drive is arranged for automatic combustion control. Fully illustrated.

187 PIPE, CEMENT LINING

Centriline Corp.—Booklet describes proved method of (1) permanently increasing and maintaining carrying capacity; (2) stopping and preventing leaks; and (3) preventing discoloration of water from corrosion. Typical installations and results are described.

Continued on Page 58

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CATALOG GUIDE

188 SILICONE PRODUCTS

Dow Corning Corp.—A reference guide to Dow Corning silicone products is a revised general catalog which lists over 50 different Dow Corning silicones according to their physical form and applications. Important properties of each product and code numbers for obtaining more information about any particular product are conveniently presented in this 4-page bulletin.

189 FEEDWATER AND PROCESS WATER CONDITIONING

Cochrane Corp.—Condensed 4-page bulletin describes hot-process water softeners, and hot zeolite water softeners for boiler feed; sodium zeolite water-softeners and hyorogen zeolite water softeners featuring the Cochrane hydromatic single-control valve; deaerators, both tray type and atomizing type; demineralizers; filters; continuous blow-off systems; condensate drainage control systems; relief valves, drainers, and separators.

190 SPRING WASHERS

Wallace Barnes Co.—Pamphlet gives sizes of 536 different dies which are available for making slotted, wavy, curved, and Belleville spring washers. Use of this list in designing special spring washers avoids tool charges. Pamphlet also gives stock sizes of finger springs and wavy washers suitable for loading bearings and similar applications from $^{1}/_{8}$ in. OD to $4^{3}/_{16}$ in. OD.

191 GEAR TURBINES

Westinghouse Electric Corp.—Booklet No. B-4346. The efficiency of high-speed single-stage steam turbines is brought to slower-speed-driven equipment such as pumps, fans, compressors, and generators with low operating cost and minimum maintenance. The type-E turbine close-coupled to a rugged, compact, speed-reduction unit is the answer. Fully illustrated and diagramed.

192 TECHNICAL BOOKS

Lefax Publishers—Over 2000 listings of Lefax pocket-size technical books are contained in the newly revised 1951 Lefax catalog. Condensed, mathematically accurate source materials for engineers, construction men, technical workers, and technical students. Each book consists of approximately 140 pages of easily read tables and data in pocket-size, loose-leaf form for handy reference right on the job.

193 FLEXIBLE SHAFT POWER DRIVES

Elliott Mfg. Co.—Catalog No. 207, describes applications of flexible shafts for power drives and heavy-duty power drives. It gives factors which determine specifications and primary requirements in engineering flexible shaft power drives. It lists information required by Elliott engineering service in offering solutions to power transmission problems, without cost or obligation.

194 AUTOMATIC CONTROLLERS

Foxboro Co.—Bulletin No. 381 presents the many unusual features of the model 40 controller, and shows the various available tyes of this well-known member of the extensive Foxboro line of industrial instruments. Other bulletins cover individual subjects including indicating, recording, and controlling instruments of different kinds, whether pneumatic, electric, or electronic.

195 CENTRIFUGAL PUMPS

Byron Jackson Co.—**Pump Div.**—Bulletins describe individual BJ pumps such as the submersible, deep-well, turbine, hydraulic press, boiler feed, vertical circulating, stuffing boxless, multiplex, process, sump, vertical propeller, pipe line, pneumatic sponge, double case hot oil, bulk station, sand and gravel, and other standard and special centrifugals. Other bulletins describe special BJ engineered features such as the mechanical seal, double volute, etc. In addition bulletins are available on BJ pumps applied to specific markets such as irrigation, mining, milling, smelting, pulp and paper, and sugar industries. Most of the individual pump bulletins contain assembly and construction detail drawings, installation photos, size, capacity, and other specifications and engineering details. Special engineering assistance is also offered on specific pumping problems.

196 OIL BURNERS

Ray Oil Burner Co.—A condensed 16-page catalog in color, with illustrations, capacity table, and listing the company's commercial and industrial oil and combination gas-oil burners, including: fully automatic, semiautomatic, and manually controlled horizontal rotary types and steam turbine drive; commercial and domestic pressure atomizing types for oil or combination gas-oil.

CATALOG GUIDE

197 WEIGHING AND COUNTING SCALES

Toledo Scale Co.—Brochure of 36 pages shows a wide range of applications of modern weighing, counting, and force-measuring equipment; also presents historical background on development of modern scales and balances. Published in connection with 50th Anniversary of Toledo Scale Co.

198 METAL FABRICATION

L. O. Koven & Brother, Inc.—Bulletin No. 490 is a 24-page brochure illustrating by photographs and sketches the complete story of Koven's experience, knowledge, and facilities in the field of metal fabrication.

199 REPRODUCTION MATERIALS FOR ENGINEERING

Eastman Kodak Co.—A line of photographic materials for engineering drawing reproduction is described in a new Booklet, "Modern Drawing and Document Reproduction with Kodagraph Reproduction Materials." Of particular interest to engineers are three direct-to-positive printing room-light-handling materials . . . Kodagraph Autopositive Paper, Kodagraph Autopositive Film, and Kodagraph Autopositive Cloth, which have valuable applications for making intermediates. They can be exposed with conventional drafting-room equipment.

200 ASH AND FLY-ASH CONVEYERS

Hahn Equipment Corp.—Six-page catalog with supplements, describes and illustrates an economical pipe-line or pneumatic unit in team consumption and maintenance. Great stress is laid on the best layout in every given case. Existing conveyers can be easily improved with considerable economies in operation and maintenance.

201 BLOWERS, EXHAUSTERS, PUMPS, ETC.

Roots-Connersville Blower Corp.—Regularly issued individual bulletins covering centrifugal blowers and exhausters; rotary positive blowers, gas pumps, liquid and vacuum pumps; positive displacement meters, and inert gas generators.

202 WATER-TREATING EQUIPMENT

Hungerford & Terry, Inc.—Bulletin No, BFT-1 describes and illustrates zeolite and cold process softening, partial and complete demineralization; any of which is available for manual or automatic operation on any water supply for any water requirements. Equipment for tailor-made water is described.

203 MARINE BOILERS AND STOKERS

James Leffel & Co.—New 28-page Bulletin No. 236, describes 6-hp to 250-hp (these are normal and conservative ratings and are subject to considerable overload capacities) Leffel Scotch type boilers and underfeed stokers. Photos and cutaway drawings show design and application details. Test results, case studies, and specification data are included. The Leffel automatic underfeed stoker which is also suitable for other makes of Scotch-type boilers is described.

204 VIBRATING SCREENS

Link-Belt Co.—20-page book No. 2377 describes Model "UP" vibrating screens for fast accurate dry-screening of light and fine materials, and model "NRM" liquid vibrating screens for low-cost, high-speed separation of solids from liquids. Descriptive material includes specific information on how to select the right screen and screen cloth for maximum operating efficiency.

205 PIPE AND TUBES

National Tube Co., Tubing Specialties Div.—Bulletin 26 presents technical data on 25 alloy steels suitable for high-pressure high-temperature service. Includes many tubular products manufactured in accordance with ASME Boiler Code specifications. Relative cost figures aid in selecting best alloy for special service.

206 GRINDERS

Ingersoll-Rand Co.—A folder featuring the new series 4 grinder describes how the new overspeed safety coupling eliminates the possibility of dangerous overspeed operation by automatically uncoupling arbor and wheel from the motor, making it impossible to operate the grinder until the cause of overspeeding has been corrected. Along with a table of specifications many other new features of design are included.

207 SLITTERS AND SLITTING LINES

Yoder Co.—Basic information on design, selection, and operation of slitters and slitting lines; time studies and analysis of operating cycle; and coil,

Continued on Page 69

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handling and scrap-disposal methods are presented in 74-page Catalog. Specifications, capacity tables, and other data on Yoder standardized series of uncoilers, slitters, recoilers, coil cars, and scrap choppers are given.

208 INDUSTRIAL OIL BURNERS

Petroleum Heat and Power Co.—New completely revised 24-page catalog No. 150 offers up-to-date information about Petro industrial (heavy) oil-burning equipment, including combination gas and oil burner for use with fuel oils up to the viscosity of preheated No. 5 oils or 1000 Btu natural gas. Also condensed data on Petro domestic oil-burning equipment.

209 PROTECTIVE COATINGS

Insul-Mastic Corp. of America—Booklet describes Insul-Mastic protective coatings and methods of application that now make available, in one application operation, coverings 10 to 30 times as thick as coatings of conventional paint. Composition, properties, and method of application, are included.

210 AIR CONDITIONING—REFRIGERATION

Baker Refrigeration Corp.—Revised "Story of Baker" describes Baker's outstanding achievements in air conditioning and refrigeration since the company was organized by Joseph Baker in 1905 at Omaha, Neb. Cutaway model reproduction defines features from compressors 1/3 to 60-hp ammonia units 2 to 125 hp, evaporative condensers, water towers, air-handling units, air-conditioning coils, Bakeraire self-contained air conditioners 3 to 10 tons, central-air central stationed units 5 to 40 tons.

211 INDUCTION HEATING

Ohio Crankshaft Co., Tocco Div.—New catalog 22, 20 pages, describes the principles, applications, and equipment of Tocco induction heating. Typical results of induction hardening and heat-treating, and results of induction heating for forming and forging are given.

212 STEEL CASTINGS

Continental Foundry & Machine Co.—Twelve basic considerations which should govern the selection of a supplier of steel castings—and other industrial suppliers as well—are reviewed in new 32-page brochure.

213 PLUG VALVES

Kerotest Manufacturing Co.—Bulletin No. TS-50 describes a new nonlubricated plug valve, called Kerotest general twin seal valve, for operation in normal to subzero temperatures, on all types of gaseous and volatile liquid service.

214 HIGH-PRESSURE PUMPS

Aldrich Pump Co.—New Aldrich Data Sheet 64-B describes the recently designed Aldrich 5-in-stroke Multiplex direct flow pumps. This 6-page bulletin covers design advantages, construction, specifications, and drive requirements. Also included are a pump selection chart; dimension drawings; plunger, pressure, and capacity data on both the 5- and 7-plunger units.

215 MICROMATIC MICROHONING

Micromatic Hone Corp.—Cross-Hatch a bimonthly publication describing and illustrating the fundamentals of the Microhoning process. Each issue graphically presents the full story of one type of equipment or application. Photographs of equipment in actual operation are given with the complete story of the accomplishments. Back issues are available.

216 LUBRICATION

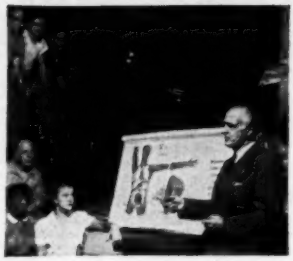
Brooks Oil Co.—New 24-page brochure, commemorating the company's 75th anniversary, combines both technical data and historical information about the company. Included in the technical section are details on lubricants, such as Lesdolene, Klingfast, and Roll Oil F.

217 GAS HOLDERS

General American Transportation Corp.—Bulletin No. WG-22 entitled "Wiggins Gasholder" describes a gas holder which is absolutely dry requiring no water, tar, or grease to seal the gas. The synthetic rubber seal eliminates costly maintenance and operating expenses of other gasholder types. Designed to handle industrial and chemical process gases.

218 METALLURGY

Molybdenum Corp. of America—Timely information on alloying materials is given in separate pieces devoted to molybdenum wrought steels, molybdenum cast steels, molybdenum cast irons, and to tungsten in steel manufacture. Compositions, procedures, and data on results are given. A general catalog includes the metallurgical uses of boron.



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219 HEAT EXCHANGERS, EVAPORATORS, FEEDWATER HEATERS

American Locomotive Co., Alco Products Div.—Catalog No. AL-3, 16-page general catalog, describes Alco's products and manufacturing facilities, including data and illustrations on conventional, multipurpose, and air-cooled heat exchangers; evaporators, feedwater heaters, pressure vessels, prefabricated piping, and welded steel pipe. Construction and application of patented flex-tube evaporators are described and illustrated, together with selection data on heat exchangers.

220 PRESSURE REGULATORS

Chaplin-Fulton Manufacturing Co.—Bulletin 46 describes Model 46 pressure regulator. Two new features are used in this design: The O-Ring to replace the stuffing box, and the "Dynaknob" to improve the degree of accuracy in outlet pressure control.

221 CONVEYERS

Lamson Corp.—Bulletins in looseleaf form, bound in cover, embrace various types of roller gravity and power conveyers together with the automatic pallet loader and pneumonatic dispatch tubes. Considerable information is available to help in determining the types of equipment to solve various problems and a substantial number of application pictures that suggest ideas and arrangements for various handling conditions.

222 ELECTROSTATIC CLEANING

Trion, Inc.—Designers and manufacturers of equipment for electrostatic cleaning and purifying of air or other gases offer catalog Form E-22 as a convenient tool for engineers and industrial designers. Featured with all Trion equipment is the built-in washing system which makes it unnecessary for maintenance personnel to enter the ductwork to remove the collected dirt and impurities.

223 WATER VAPOR PHYSICS

Pittsburgh Lectrodryer Corp.—Bulletin No. 218, "The Moisture in Our Atmosphere," a 12-page bulletin, discusses the fundamental physics of water vapor. The nature and behavior of water vapor are treated in a logical down-to-earth manner with psychrometric chart explanations. The use of solid adsorption equipment for dehumidification is also described.

224 ELECTRIC HEATING UNITS

Edwin L. Wiegand Co.—Chromalox Industrial Electric Heating Unit Catalog 50 lists, strip, Finstrip, ring, and cartridge elements; oven and duct heaters; wide range of immersion and circulation heaters, all-metal infrared heaters, unit heaters, hot plates, thermostats, contactors, and hardware. Includes detailed specifications, uses, prices, and application data.

225 TECHNICAL BOOKS

Ronald Press Co.—A 73-page booklet describing over 100 of the most recent publications in the engineering, administration, and technical fields. Written by recognized authorities, these books are of interest to engineers, executives, and industrial research workers who want up-to-date information and reliable data in their specialized professions.

226 TUBE FITTINGS

Parker Appliance Co.—Catalog No. 203 describes Parker industrial tube fitting in all current types, sizes, shapes, and material. This catalog also includes a section on tube fabricating equipment, information on flaring tools, tube cutters, hand tube benders, and bench-mounted tube benders.

227 MECHANICAL SOOT BLOWERS

Hahn Equipment Corp.—Four-page catalog with supplements, describes and illustrates the fixed-nozzle-type soot blower, that will positively clean each tube end to end. Operation requires about one minute with either steam or compressed air.

228 TEMPERATURE AND PRESSURE REGULATORS

Fulton Sylphon Div.—Robertshaw Fulton Controls Co.—Well illustrated Catalog A describes the Fulton Sylphon line of regulators for temperature and pressure control. This catalog also gives technical information relating to relief valves, pump governors, safety and vacuum regulators. In all there are over 200 pages of illustrations, data, and drawings.

229 SPACE HEATERS

Dravo Corp.—Bulletin No. 526 describes Dravo "Counterflo" direct-fired space heaters in a range of gas- or oil-fired models with outputs from 400,000 to 2,000,000 Btu per hr. A comparison chart shows that steel requirements for these heating systems can be reduced 50 to 70 per cent through the use of direct-fired warm air heaters.

230 BITUMASTIC PROTECTIVE COATINGS

Koppers Company, Inc.—Informative package of six bulletins covers (1) Bitumastic Hi Heat gray for high-temperature corrosion prevention; (2) Bitumastic Black Solution for general, low-cost maintenance; (3) Bitumastic Super-Service Black, heavy-duty coating for more severe conditions; (4) Bitumastic No. 50, extra heavy-duty coating for extremely severe corrosive conditions; (5) Bitumastic No. 28, heavy-duty coating for atmospheric corrosion control; (6) Bitumastic Tank Solution, quick drying, useful for water tanks, air-conditioning equipment, etc.

Continued on Page 62

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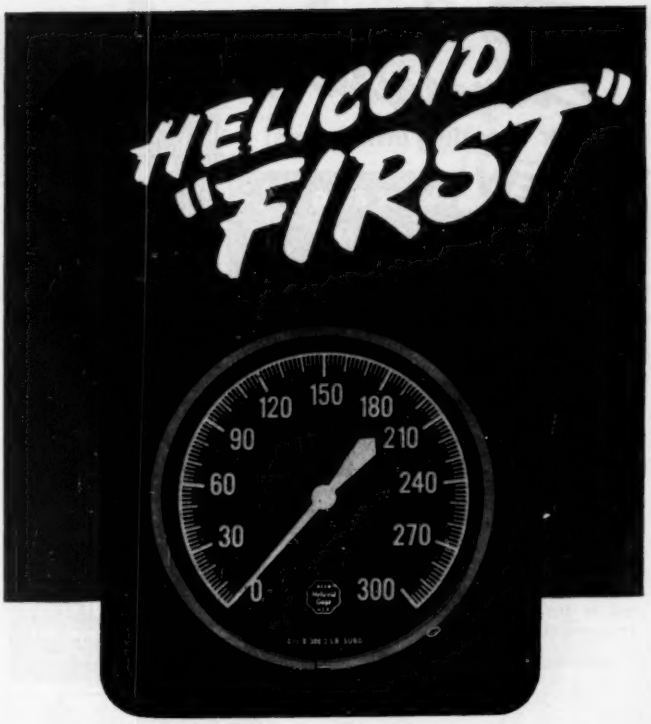

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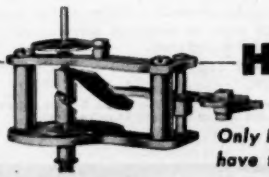

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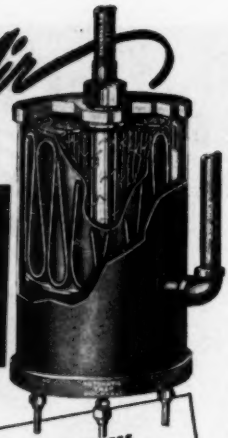

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231 ELECTRIC PROCESS HEATING

Advance Heating Div., Jensen Specialties, Inc.—6-page bulletin, illustrated, on electric heating ovens, driers, and booster heaters for finishes, varnishes, coatings, textiles, paper, glazes, adhesives, cements, foundry molds and cores, preheating castings, expanding metal parts, and many other applications. Describes electrical construction, mechanical and thermal features and capacities. Also informational form to secure specific recommendations.

232 INSTRUMENTS—RECORDERS

Brush Development Co.—Brush recording analyzers provide immediately usable, permanent records of data on special problems: electrical, mechanical, acoustical. New bulletin describes recording analyzers applicable to studies of d-c or a-c voltages or currents, strains, displacements, light intensities, temperatures, other static or dynamic conditions; oscillographs, amplifiers, instrument accessories, acoustical instruments.

233 STEAM GENERATORS

Ames Iron Works—Catalog No. 1011-CME illustrates internal and external details of the Amesteam Generator and indicates standard sizes, pressures, and fuels.

234 TECHNICAL SERVICES

Vitro Corp. of America—Booklet outlines services of Vitro Corp., formerly the Kellex Corp., which include research and development, process engineering, design engineering, product engineering, construction, and operation, etc.

235 BALL BEARING SWIVEL JOINTS

Chikaan Co.—Catalog No. 51-C illustrates and describes complete line of over 500 different types, styles, and sizes, with data on working pressures, maximum temperatures, dimensions, and weights. 12-page catalog No. 2A gives data on aircraft-hydraulic swivel joints for pressures from 1000 psi to 3000 psi.

236 SUBMERSIBLE SUMP PUMPS

Kenco, Inc.—Circular No. 10 gives detailed data on submersible sump and utility pumps. This submersible feature eliminates the need for a permanent pump mounting. The bulletin gives a list of applications, a view of the pump installed in a sump, complete specifications, and prices.

237 STEEL SHAPES AND SHELLS

Pressed Steel Tank Co.—New bulletin illustrates pressed steel shapes and shells; shows pressed steel shells and shapes used in so many applications—many times replacing welded tubing, cast steel parts; eliminating necessity for expensive machining.

238 SELF-ALIGNING COUPLINGS

Koppers Co., Inc.—Fast's Coupling Dept.—Six-page folder on Fast's self-aligning couplings gives graphic illustrations of principles and features of these couplings; table of utility factors for various kinds of connected machines; and tables of ratings for standard forged-steel couplings and heavy-duty-type couplings.

239 ELECTRIC HEATING UNITS

Watlow Electric Mfg. Co.—Catalog describes complete line of cartridge, strip, immersion, and cylindrical heaters, giving complete specifications of every unit. Tables and charts are included to provide heat characteristics of various solids, liquids, and gases.

240 CONVEYER ROLL BEARINGS

Marlin-Rockwell Corp.—M-R-C conveyer roll bearing bulletin (Form 1529) is a 4-page, 8½ × 11-in. illustrated folder on M-R-C CONV-3-SF and CONV-4-SF ball bearings. These bearings are specially designed for use on conveyer rolls, and have four important features, resulting in reduced machining operations, cheaper mounting costs, reduced belting cost, and improved belt alignment.

241 PRECISION DEEP DRAWING

Hydropress, Inc.—"Better Form with Marform" is the title of a new 12-page folder on the Marform precision deep-drawing process and its equipment. Many illustrations.

242 ELEVATOR PLANTS

Charles W. Lerch & Assoc.—"Cost of Errors In Elevator Plants" is a new booklet for all building owners, managers, and administrators—especially those who operate office buildings, hospitals, lofts, apartments, and hotels.

243 HYDRAULIC LUBRICANT PUMP

Trabon Engineering Corp.—Bulletin No. 514 gives complete data on the "Hydra-Lube" pump and reservoir assemblies for oil or grease systems. Readily adaptable to machine tools, mining machines, presses, and other equipment using hydraulic power. Adjustable volume discharge gives fully automatic lubricating system without electric or mechanical connections.

244 FLEXIBLE SHAFTING

F. W. Stewart Mfg. Corp.—Bulletin "Flexible Shaft Assemblies," describes new power drive circle Eas flexible shafting. Greater opportunity for diversified streamlined power transmission is offered for use in all types of metal, plastics, porcelain, or woodwork. They can be applied in hundreds of finished operations. Three types of power drive flexible shafts are presented—for heavy, medium, and light duty in commercial or industrial work.

245 HELICAL GEAR SPEED REDUCERS

Foote Bros. Gear and Machine Corp.—Manual LPB illustrates, describes, and contains complete application data on Line-O-Power straight-line helical gear speed reducers. This new line features Duti-Rated high hardness precision helical gears assembled into rugged cast housings of streamlined design. These drives are available in double or triple reductions with ratios up to 238 to 1 for capacities up to 200 hp.

246 RECORDING MECHANICAL COUNTERS

Streeter-Amet Co.—New illustrated bulletin on latest recording mechanical counters actuated by electrical impulses. Many new uses for these recording counters are depicted for industry as well as for science. Machine shops, airports, hospitals, scientific laboratories are among the wide range of fields where they can be used with profit. Variable components multiply the recording possibilities for a variety of counting and timing jobs.

247 BOILERS AND RELATED EQUIPMENT

Babcock & Wilcox Co.—A "Products and Facilities," bulletin G-63, illustrates representative examples of the products manufactured by the company, and some of the numerous facilities for producing them, together with illustrations of typical installations. Products described include a complete line of B&W stationary boilers and related equipment, marine boilers, chemical and heat-recovery units, process equipment, pulverizers for grinding raw materials, refractories, castings. Products of The Babcock & Wilcox Tube Co. are also illustrated.

248 OSCILLATING CONVEYERS

Link-Belt Co.—16-page book No. 2244 contains layout drawings selection charts, dimensions, and weights for the "PA" positive action, roller-bearing eccentric-type oscillating feeder-conveyer. It is particularly recommended for handling sharp, abrasive, fine, lumpy, sticky, hot, or other difficult-to-handle materials.

249 PIPE LINE STRAINER

J. A. Zurn Mfg. Co.—Engineering Data Manual No. 951 contains complete descriptive and illustrative details of pipe-line strainers for all purposes. Duplex strainers in plug, disk, and gate types; Sinlex, Y-type, and special strainers in size range from ¾ to 24 in. inclusive.

250 TANKS AND TOWERS

W. E. Caldwell Co.—New 50-page catalog No. 58 with illustrations, data, and prices on wood and steel tanks and towers for all purposes, as well as tank agitators, stirring devices, tank heaters, float valves, and many other accessories of all kinds.

251 STEEL ROLLING GRILLES

Kinnear Mfg. Co.—New 8-page bulletin No. 21-A describes all-metal rolling grille that provides an attractive barricade for openings, such as hallways, doorways, and windows. Operating like a rolling door, it can be arranged for complete concealment above the opening when raised. Gives details, clearance requirements, and available accessories.

252 HIGH-SPEED STEELS

Firth Sterling Steel & Carbide Corp.—New Technical Data Sheets have been issued on molybdenum types of high-speed steel including van chip, a high-carbon high-vanadium steel, and Circle M, a 9% cobalt-moly high-speed steel. New sheets are also available on Chimo, a silico-manganese tool steel for chisels, punches, and shear blades.

253 ELECTROSTATIC PRECIPITATORS

Koppers Co., Inc.—Precipitator Dept.—Folder describes Koppers Elex electrostatic precipitators in features and performance. Specific operating results are given as well as suggested applications in nuisance elimination, cleaning of process gases, or recovery of valuable products.

254 ELECTRONIC ANALOG COMPUTATION

George A. Philbrick Researches—Catalog and manual on Gap/R high-speed all-electronic analog computation describes line of components from which computors for many purposes may quickly be assembled; shows applications to study and design of dynamic structures and such control systems as industrial regulators and servomechanisms; presents philosophy and mathematical techniques for most effective usage.

255 POWER CHUCKS AND AIR CYLINDERS

Cushman Chuck Co.—Bulletins No. P05 Three-Jaw Compensating Jaw Chucks, and P08, Iron Body Rotating Air Cylinders give prices, engineering data on power chucking equipment designed to operate without vibration or chatter at high speeds and to provide low cost, time-saving tooling. Cushman air cylinders may be used also for operation of other makes of air chucks.

256 BOILER VALVES

Everlasting Valve Co.—A new bulletin No. E125 on valves for boiler services, such as surface blow, bottom blow-off, water column blow-off and connections, describes the Everlasting quick-opening and slow-opening straightway valves, angle valves, "Y" valves, and duplex blow-off Units, with complete specifications, materials of construction, and dimensions of each type. Illustrations include details of design, sectional and "exploded" views, and explanations of operation of the valves.

Continued on Page 64

Baking, drying, or heat-conditioning of industrial products in the 150° to 650° F. temperature range, is now simplified by the use of furnace-type Calrod heaters in standard panels for field assembling on pre-fabricated frames. Using both radiation and convection principles for rapid temperature elevation and precise holding requirements, radiant Calrod ovens produce results with shorter heating cycles, lower energy consumption, and little maintenance.

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BUYER'S CATALOG FILE

257 METALWORKING PUNCHES AND DIES

T. H. Lewthwaite Machine Co.—Notebook size catalog sheets listing in an easy-to-locate arrangement the wide range of metal working punches and dies carried in stock for immediate shipment. Styles to fit most makes of hand, foot, and power-operated punch presses are standard. Hand-operated punches, cutters, and benders are also illustrated and described.

258 STEEL AND ALLOY PLATE FABRICATION

Nooter Corp.—Catalog lists the many specialized techniques and services of Nooter in the fabrication of tanks and vessels for the petroleum and chemical processing industries. Corrosion data charts provide valuable information on resistance values of commonly used metals with reference to hundreds of chemicals.

259 LUBRICATING SYSTEM

Trabon Engineering Corp.—Bulletin No. E463 describes operating principles and engineering data on type "M and MX" oil and grease systems for all types of machinery. Fully hydraulic positive-piston-type valves measure lubricant in volumes from 0.010 to 0.15 cu in., use no springs or ball check valves. May be installed on new or machinery already in operation.

260 PISTON RINGS

Koppers Co., Inc.—Piston Ring Dept.—16-page folder describes Koppers "American Hammered" piston rings for industrial use. Individual ring types shown with specifications for use in combustion engines, hydraulic systems, compressors, etc.

261 BULK FLOW CONVEYERS

Link-Belt Co.—48-page book No. 2175, copiously illustrated, contains complete engineering data on the combination Bulk-Flo elevator, conveyer, feeder consisting of an endless chain to which cross flights are attached at intervals, all contained inside a close fitting casing. Ideally suited for handling a variety of bulk flowable granular, crushed, ground, or pulverized materials.

262 ROLLING DOORS

Kinnear Mfg. Co.—The 32-page fully illustrated bulletin No. 68 on a galvanized steel sectional overhead-type door that combines durability with operating convenience and facilities for glass light sections in a door for all types of commercial and industrial service openings is offered. It gives details, clearance requirements, and available accessories.

263 WATER TUBE HEATING AND POWER BOILERS

International Boiler Works Co.—Catalog and specification sheet describing water tube steel heating and power boilers, includes pictures and cuts showing effective baffling arrangements which provide economical performance with all fuels and any method of firing. Made in standard sizes from 10 to 600 bhp. See our performance data in 1952 ASME Mechanical Catalog and Directory, page 188.

264 FLAT LAPPING

Crane Packing Co.—12-page booklet, fully describing the new "Lapmaster" method of flat lapping to extremely close tolerances on an automatic, high production basis. Photographs, diagrammatic drawings, and complete data on "John Crane" Lapmaster Models "12" and "24" provide profitable information for all industries whose manufacturing operations include finishing parts to precision surface flatness and finish.

265 ECONOMIZERS

Green Fuel Economizer Co.—Bulletin No. 169, 8 pages, describes Green premier "Diamond" economizers with cast-iron (type 25) and steel (type 12) tubes.

266 BEARING SELECTION

W. A. Jones Foundry & Machine Co.—Catalog No. 88, a 24-page bulletin on "Timken Equipped Pillow Blocks" and a new line of "Timken Equipped Protected Screw Take-Ups," contains many illustrations and good engineering information on the rating and selecting of bearings.

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267 FLANGE DESIGN

Taylor Forge & Pipe Works—"Modern Flange Design," 1950 (Third) Edition, bulletin No. 502, presents the most current data and demonstrates the calculations required for flange design. Two editions of this manual have appeared since 1938. They have provided the designer with a convenient procedure for calculating flanges based on the methods proposed by E. O. Waters, D. B. Rossheim, D. B. Wesstrom, and F. S. G. Williams in their paper, "Formulas for Stresses in Bolted Fanged Connections" (FSP-59-4, Trans. ASME, April, 1937). This work is an extension of the Taylor-Waters formulas to cover the tapered hub condition for butt-welding flanges. The ASME Rules for Bolted Flanged Connections have also been based on these methods and the procedure suggested in this manual provides the means for orderly and systematic application of the Rules to design problems.

268 VIBRATION FATIGUE TESTER WITH THYMOTROL DRIVE

All American Tool & Mfg. Co.—Catalog page 100 Ha-T describes vibration fatigue tester which provides smooth, stepless acceleration from 10 to 100 cps by means of G-E Thymotrol electronic drive. Parts up to 100 lb in weight can be tested. Table movement is horizontal. Maximum capacity is 23 *g*.

269 TUBING

Bundy Tubing Co.—New 20-page booklet, in color, contains technical data and fabricating information on Bundyweld steel (copper or tin-coated) tubing of particular interest to production and design engineers in metalworking industries.

270 AIR-COOLED ENGINES

Briggs & Stratton Corp.—Folder printed in two colors showing complete line of current single-cylinder, 4-cycle, air-cooled engines. Includes dimensional specifications and horsepower data.

271 PILOTED TYPE COUPLINGS

Falk Corp.—Bulletin No. 4115 gives construction features, dimensions, typical applications, tables, and specifications, of Type P Falk piloted steelflex couplings.

272 GASKETS

Ernst Water Column & Gage Co.—A new high-pressure and high-temperature composition red rubber ring gage glass gasket applied to round-tubular gage glasses will not soften up or blow out under high temperature or high steam working pressures. Send for free samples to test on your boiler gage glasses.

273 MATERIALS-HANDLING EQUIPMENT

Clark Equipment Co., Industrial Truck Div.—New condensed catalog of materials-handling machines and attachments provides basic specifications for all models of Clark fork-lift trucks, industrial towing tractors, Trucktractors and special handling attachments. Information includes capacity, dimensions, center of gravity, turning radius, lift heights, etc., for both electric and gas-powered models.

274 FRACTIONAL HORSEPOWER GEARS

Gear Specialties, Inc.—6-page bulletin illustrates and describes complete facilities together with different types and applications of G.S. small gears from 12 to 96 diametral pitch. Handy diametral pitch and circular pitch charts included.

275 PUMPS

American-Marsh Pumps, Inc.—Boiler Feed and General Service Pump Bulletin No. 381 describes and pictures this ball bearing, horizontally-split case, two-stage, single-suction centrifugal pumping unit. Shows electric motor and steam-turbine-driven models, 12 important features in large cross-section, specifications, general dimensions, metal specifications, and modifications.

276 ELECTRICAL AND SCIENTIFIC INSTRUMENTS

James G. Biddle Co.—Bulletin No. 35-50 covers speed-measuring instruments including Frahm resonant reed tachometers, frequency meters, and rate-of-vibration indicators; also Jagabi hand tachometers of the centrifugal or fly-ball type, chronometric speed indicators, tachoscope, tachograph, and tachonorm. Booklet No. 21-P-8-50 covers insulation resistance testing in simple language. Bulletin No. 35-65-50 covers the Dr. Horn precision tachometer.

277 INDUCED AND FORCED-DRAFT FANS

Green Fuel Economizer Co.—Bulletin No. 168, 20

Continued on Page 66

BARCO *Flexible* JOINTS *to meet* INDUSTRY'S NEEDS

● Wherever piping connections must move, look to BARCO for the ANSWER! Whatever your problem, Barco, invariably, can solve it BETTER, EASIER, and QUICKER with a tested and proven joint right out of the standard Barco line. This is because Barco builds a truly complete line of flexible ball, swivel, swing, and revolving joints—*there is a size and type for every purpose!* Submit your problem; ask for recommendations—Barco is at your service.

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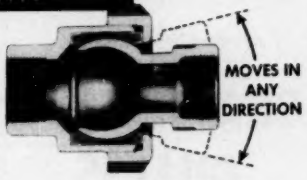
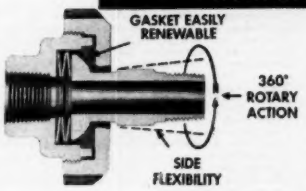
"One joint does the work of two or more!"—because it moves in any direction. Standard the world over where low cost, leakproof movable joints are needed in piping handling steam, air, water, oil, gas, or chemicals. Many models available. Up to 40° side flexibility *plus* 360° swivel action. Also used to facilitate quick connection of piping, overcome misalignment. Pressures to 6,000 psi; temperatures to 1,000° F. 15 different sizes, ¼" to 12". *Bulletin 215.*

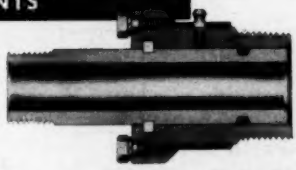


ROTARY SWIVEL JOINTS



Exclusive angular motion prevents binding—only Barco offers this important advantage! Widely used for making compact, low torque swivel connections to reciprocating or rotating ports. Easy to position piping accurately—no sagging, flopping lines. Leakproof, safe—pressure or vacuum. Ratings as high as 600°F., 3,000 psi (hydraulic). Sizes, ⅜" to 2"; angle or straight. *Bulletin 265.*

SWING JOINTS



Here is a simple, low cost, precision-built swing joint that is ideal for many applications: oil loading and unloading lines, hose reels, water connections. "O" ring gives leakproof seal. Full bearing surface, swiveling 360° in one plane only, supports normal piping. Built for hydraulic pressures to 500 psi; temperatures, −40° to 225°F. Male or female pipe thread connections, angle or straight. Sizes, ⅜" to 12". *Ask for literature.*

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Bulletin 300:
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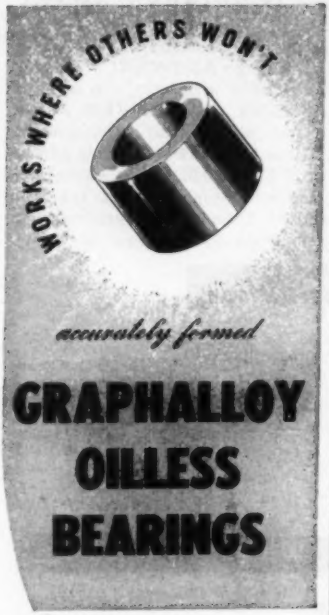

pages, describes the Green line of induced and forced-draft fans; including stack-supporting fans. Many variations noted.

278 WEAR-RESISTANT METALS

Carboloy Co.—Reprint of an article entitled "What Are Carbides Good For?" dealing with properties of ultra-hard wear-resistant carbide metals, together with illustrated examples of their use to eliminate wear at critical points in typical mechanical products. Also includes brief review of their use for cutting tools, sheet-metal dies, etc.

279 MONORAIL TRACTOR

Detroit Hoist & Machine Co.—Bulletin No. 810 illustrates and describes a new idea in traction effectiveness which has been included in the new Trojan, electric motor traveled, monorail tractor for traveling various materials handling and other types of units on monorail tracks or rails by electric power. Many material-handling and various other types of units at present hand-operated and difficult to move can be power-traveled faster and economically by this tractor.

280 AUTOMATIC VALVES AND CONTROLS

A. W. Cash Co.—Bulletin No. 330, reviews in the briefest possible manner the more commonly used valves, regulators, and controls for pressure regulating, volume flow, and liquid level. The illustrations and descriptions shown in the bulletin, brief as they are, will show the broad scope of automatic control, and suggest the possibilities which proper application of these devices can serve.

281 CENTRIFUGAL PUMPS

Dean Bros. Pumps, Inc.—New 28-page catalog describing complete line of centrifugal pumps for industrial, chemical, petroleum, and general service. Photographs, sections, selection tables, parts lists, dimension sketches, and material specifications serve to illustrate the large degree of interchangeability and adaptability that has been achieved in the design of these pumps.

282 CHAIN-GRATE STOKERS

Illinois Stoker Co.—Catalog describes a chain-grate stoker with medium-height side frames for installation under boilers up to about 500 hp. The side frames are of ample height to admit sufficient air required for combustion and this construction saves at least one foot in the setting height of the boiler. The stoker is used for either free-burning bituminous coal or anthracite.

283 CONVEYERS AND MATERIALS-HANDLING EQUIPMENT

Mechanical Handling Systems, Inc.—Illustrated bulletins including engineering data covering materials-handling problems. Bulletin M-3, "Monoveyors," contains complete information on overhead trolley conveyers. F-5, Floor Type Conveyers. L-1, "Eleveyors," portable and adjustable inclined belt conveyers. TV-1, "TwinVeyors," flexible and portable conveyer for bagged goods. RV-1, "Rope Veyor," flexible and portable conveyers for bags, cartons, cases, packages, etc. R-2, "Universal Work Carriers," tiering racks for transportation and storage of miscellaneous products. C-1, "Collapsi-Bin," combination heavy-duty bin, rack, and pallet in one unit.

284 CAST-IRON PULLEYS

W. A. Jones Foundry & Machine Co.—Catalog No. 83, shows standard as well as special pulleys, contains engineering data to help you with your design problems and complete price information on all types of standard pulleys.

285 STEAM TURBINES

Murray Iron Works Co.—Bulletin T-122 illustrating and describing Murray Type UV steam turbines. Type UV turbines are designed for modern steam pressures and temperatures. UV turbines may be provided with features and accessories for any type of drive.

286 POWERED HAND TRUCKS

Clark Equipment Co., Industrial Truck Div.—New powered hand trucks, electric and gas-powered with motors mounted in the drive wheel, are described in a Clark booklet. The gas-powered model employs a hydraulic drive, with engine power transmitted through a variable displacement hydraulic pump to a constant displacement hydraulic motor.

287 PACKINGS FOR CHEMICAL INDUSTRY

Crane Packing Co.—New booklet entitled "Packing for the Chemical Industry" is designed to give a complete picture of packing requirements for practically all chemical applications. Each "John Crane" style is fully explained and illustrated, and recommendations are made for specific services and

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temperatures. A special feature of this new booklet is a section devoted to "Chemlon," the new Crane Packing Co. Teflon development in chemically inert packings. The material is completely inert in most chemicals with the exception of molten alkali metals. Styles include both braided form and molded rings. Specific recommendations for each are included.

288 PRESSURE REGULATORS

Davis Regulator Co.—Bulletin No. A-50 describes the standard Davis line of pressure regulators and reducing valves for steam, air, gas, water, oil, and other fluids. Complete data on 18 standard types in sizes up to 24 in. and for pressures to 1500 psi.

289 A MODERN FORGE SHOP

Kropp Forge Co.—Vol. 10, No. 3, issue of Forgings describes the growth of America's largest job forge plant and gives a pictorial trip through each department of the company . . . explaining how Kropp forged parts have rendered valuable service to the automotive, aviation, machine tool, petroleum, construction, and other industries.

290 V-BELT DRIVES

Medart Co.—Bulletin VE-48. A complete new bulletin on the engineering of V-belt drives, containing the new Medart type SL V-belt sheave. Complete engineering tables and drive section tables in condensed and easy to interpret arrangement.

291 FURNACE ENCLOSURES

M. H. Detrick Co.—Forthcoming publication of a comprehensive review of the development of the art of enclosing heat under the title of Heat Enclosure Methods. The text and illustrations will trace each step in the development of modern furnace enclosures from the early sprung arches and solid brick settings to the present suspended and supported walls and arches.

292 SPEED REDUCERS

W. A. Jones Foundry & Machine Co.—Bulletin No. 68 covers the latest information on Jones worm gear speed reducers. Heavy-duty machines are furnished in type "H" with worm below gear and in type "R" with worm above gear. They have horsepower ratings in accordance with the recommended practice of the American Gear Manufacturers Association.

293 SPREADER STOKER SELECTION

American Engineering Co.—14-page form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered in the selection. It pictures and describes in detail the principle operating parts of manufacturer's stokers, emphasizing their advantages. Includes engineering drawings and photos of several typical installations.

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294 THREAD INSERTS

Heli-Coil Corp.—New 16-page two-color bulletin covers design data on helical-wire thread inserts and the use of these inserts in the protection and repair of tapped holes. Detail drawings and text explain how these inserts are used as original manufacturing components to protect tapped threads in aluminum, magnesium, plastics, iron, steel, and wood against stripping, wear, corrosion, seizing, and galling. Tabular data is included.

295 GEARS

Earle Gear and Machine Co.—Illustrated 24-page, 2-color booklet includes photos and descriptions of Earle metallic spur, bevel, helical, and worm gears; nonmetallic gears; and other products.

296 OIL BURNERS

Hauck Mfg. Co.—How guesswork and product spoilage can be minimized on industrial heat processing furnaces, is explained in 24-page catalog No. 410 describing the Hauck proportioning oil burner. Cutaway views illustrate the single lever control design for regulating both oil and air simultaneously. Fuel-air ratio is automatically maintained at all firing rates.

297 MECHANICAL DRIVE TURBINES

General Electric Co.—Bulletin GEA-4955A, "A New Standard In Mechanical Drive Turbines," describes G-E's new type DP line of turbines in 19 pages and 21 illustrations. Designed to drive pumps, fans, compressors, blowers, and similar equipment, these turbines utilize pressure lubrication, balanced valve design, and nonsparking emergency governors. Ratings range from 10 to 1200-hp and 1000 to 5000 rpm.

298 SAFETY-RELIEF VALVES

Farris Engineering Corp.—34-page manual, "Principles of Manifold Piping Applications with Farri-Seal and BalanSeal Safety-Relief Valves," challenges conventionial economics of such systems. By balancing out the effects of back pressure, BalanSeal assures operation at the set pressure regardless of back pressure and smaller discharge piping can be safely used.

299 TEMPERATURE REGULATORS

Powers Regulator Co.—Bulletin No. 316 describes a new expansion-stem-type regulator used to maintain liquids or air at any temperature by controlling pneumatic or water-operated diaphragm valves or dampers. It is of simple rugged construction which withstands vibration, adjustable sensitivity, and overheat protection, calibrated dial adjustment, temperature ranges from 50 to 250 F and 150 to 350 F, and easy installation.

300 CENTRIFUGAL COMPRESSORS

Carrier Corp.—New 32-page book entitled, "Centrifugal Compressors for Industry," covers the application and advantages of centrifugal compressors in petroleum and chemical processes requiring compression of gases or refrigeration. Fully illustrated with diagrams, charts, and photos of installations, it also contains engineering data and simple selection methods.

301 PACKAGED BOILERS

Erie City Iron Works—Bulletin SB-38ME describes the Keystone 2-drum water-tube packaged-type steam generator. Shop assembled to include steel-cased boiler on steel base—boiler trim, induced-draft equipment, combustion control—safety controls, burner for oil or gas or for both interchangeably. Capacities: 2490 lb of steam per hr to more than 26,550. Pressures: 160 psi and higher.

302 SINTERED CARBIDES

Firth Sterling Steel & Carbide Corp.—A completely new catalog covers Firthite sintered carbides which include standard tips and tools, boring tools, tips for the wood-working industry, complete line of Firthite mining tools, Firthaloy wire and tube drawing dies, Firthaloy heading and bolt sizing dies, mandrels, nail tooling and Diecarb.

303 METALLIC BELLOWS

Chicago Metal Hose Corp.—A 16-page catalog contains information and complete specifications on metallic bellows of stainless steel, brass, bronze, and other alloys. Also included is complete information on the company's several types of flexible metal hose and tubing.

304 ELECTRIC BRAKES AND CLUTCHES

Warner Electric Brake & Clutch Co.—Catalog No. 701-A contains information on complete line of elec-

Continued on Page 68

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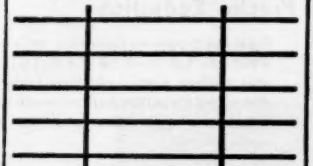

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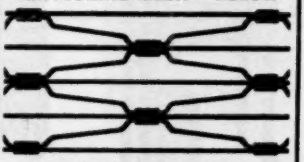

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tric brakes and clutches for industrial application. Contains general description, torque values, and general data pertaining to all sizes. Complete capacity tables, dimensions, and specifications are included.

305 RELIEF VALVES

Crosby Steam Gage & Valve Co.—Catalog No. 300. Crosby-Ashton introduces a new simplified system of relief-valve-style nomenclature. Multicolored charts make valve selection easy. Pressures have been greatly expanded and aligned with ASA ratings for steel flanges. Many new valves have been added to round out the line. A section of useful engineering data is also included.

306 AIR-CONDITIONING EQUIPMENT

Bush Mfg. Co.—Catalog No. 425 contains valuable engineering information, descriptions, and specifications covering the Bush line of air-handling units, coils, comfort conditioners, cooling towers, and evaporative condensers. Design data assists in properly engineering the job and properly selecting the correct Bush unit.

307 NOZZLES, NECKS, FLANGES

Taylor Forge & Pipe Works—New Taylor Forge Catalog No. 501 describes and illustrates Taylor forge nozzles, welding necks, and large-diameter flanges. Also included are data covering standards of the Tubular Equipment Manufacturers Association (TEMA Standards). The Taylor Forge publication, Modern Flange Design, is also incorporated as a part of this catalog.

308 MATERIALS-HANDLING EQUIPMENT

Clark Equipment Co.—Condensed catalog contains basic specifications of Clark line of materials-handling equipment, including fork-lift trucks, both gas-powered and electrics, on solid tires and pneumatic tires; industrial towing tractors; hand trucks and hand stackers, both gas and electric; and the complete line of 20 special attachments designed for particular needs.

309 FANS

New York Blower Co.—Portable self-contained units of medium capacity for ventilating and industrial applications. New 8-page bulletin, No. 512, describes these fans, furnished in four types and nine basic sizes with capacities from 160 cfm to 18,000 cfm, together with dimensions and engineering data.

310 PUMPS AND SEPARATORS

Kraissl Co.—Catalog in loose-leaf form gives data on products and indicates as briefly as possible the important features of each product or item. The recent loose-leaf additions to this catalog include the new Kraissl class 23 series air pumps for the printing and packaging machinery field, which require no oil lubrication. Other data sheets describe the complete line of Kraissl separators including both strainers and filters.

311 AUTOMATIC CONTROLS

Taylor Instrument Companies—48-page catalog No. 5 describes instruments manufactured for air conditioning, heating, and ventilating applications. Catalog presents many different types of control problems illustrated by schematic diagrams. An instrument section gives details on automatic, air-operated control instruments, thermal systems, and charts.

312 OIL SEALS

National Motor Bearing Co.—Catalog No. 101 lists standard types and sizes of National oil seals. Listings are presented two ways: (1) By shaft diameter and (2) by seal or design number. Listings indicate proper housing bore and OD ratio, as well as thickness of the oil seals. Molded synthetic rubber parts available from a National Motor Bearing subsidiary, Arrowhead Rubber Co., Downey, Calif., are also shown. A supplement to catalog No. 101, available separately, lists National Syntech oil seals.

313 VALVES

Lunkenheimer Co.—"Lunkenheimer Guide" is an illustrated, thumb-indexed catalog of representative Lunkenheimer valves—iron, steel, and bronze—in all pressure classes. Also gives complete information on Lunkenheimer boiler mountings and lubricating devices. Includes information for selecting and specifying hundreds of popular Lunkenheimer valves.

314 OIL AND GAS BURNERS

Iron Fireman Mfg. Co.—New 16-page, 3-color general catalog No. 2129 presents the complete line of Iron Fireman automatic firing equipment, including industrial and commercial oil and gas burners, combination oil-gas burners, pneumatic spreader and underfeed stokers for power and heating applications. Includes descriptions, illustrations, engineering data, and Selector Guide-Capacity Tables covering all equipment.

315 LIQUID METERS

Neptune Meter Co.—New 20-page bulletin describes meters for handling over 100 industrial liquids in processing, batch mixing, cost control operations. Includes Auto-Stop meter with automatic quantity control for accurate formulas. New meter-selector charts give complete selection and specification data for over 30 different liquid meters. Capacities from 2 to 1000 gpm, temperatures to 250 F, pressures to 500 psi.

316 MECHANICAL DRIVE TURBINES

General Electric Co.—A new two-color 20-page booklet on multistage, mechanical-drive turbines, bulletin No. GEA 5580, describes types DP, DR, and DRV multistage mechanical-drive turbines, showing cross sections, schematic diagrams of lubrication systems, and detailed description of all major components. It also includes suggested procedures for calculating steam rates.

317 INDUSTRIAL TELEVISION

Diamond Power Specialty Corp.—Bulletin No. 1025 on the "Utiliscope" discusses wired television for industry, research, commerce, education, science, and many other uses. Complete installation consists of a camera, small power unit, and the monitor or viewing unit.

318 STAINLESS-STEEL HANDBOOK

Allegheny Ludlum Steel Corp.—New data and handbook on stainless steels has been published. In its 120 pages the cloth-bound volume discusses approximately 40 different types of Allegheny Metal stainless steel and covers each type from standpoints of analyses, fabrication, heat-treatment, and special conditions of service.

319 GRAVIMETRIC (WEIGHING) FEEDER

Omega Machine Co.—Bulletin No. 35-H5 on its new "Chemizer"—belt gravimetric (weighing) feeder describes the Model 50-8 for water and sewage works. Features presented and discussed

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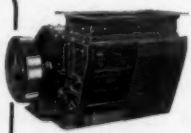

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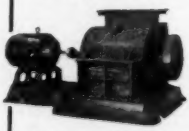
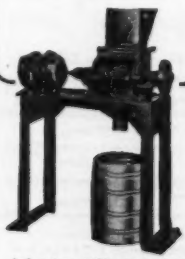


"84" Series—ring or hammer crushers. Capacities to 50 TPH.



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320 HYDRAULIC TURBINES

James Leffel & Co.—Two new bulletins tell about recent Leffel hydraulic installations. Bulletin No. 1085 describes the Leffel installation at the Bureau of Reclamation's new Anderson Ranch Dam, with photos, statistics, etc. Bulletin No. 1086 contains information on a Leffel turbine used in the expansion of TVA's Wilbur Dam, with photos, field-test results, cross-section of installation, etc.

321 FLEXIBLE CONTROLS

American Chain & Cable Co., Inc.—"Key to Remote Control," DH-287, is a 12-page 8½ x 11-in. booklet describing Tru-Lay Push-Pull flexible controls which provide a means of transferring push and/or pull movements from one location to another. Illustrates how the Tru-Lay Push-Pull is constructed, how it functions, the five sizes, standard bracket type, and special purpose heads and sliding sleeve and special terminals.

322 VIBRATION FATIGUE TESTING MACHINES

All American Tool & Mfg. Co.—Catalog No. F, 12-pages, describes all models—vertical and horizontal table motion—manual or automatic control. Outlines application. Gives handy nomograph and list of users.

323 PHOSCOTE PROCESS

Chicago Bridge and Iron Co.—A new 8-page booklet, "The Phoscote Process," contains information on the pickling and painting of steel plates, angles, channels, and other shapes produced by rolling. The booklet contains photographs and drawings showing the various operations during the Phoscote process. Also, photographs of completed structures which have been built of plates and shapes treated by the Phoscote process.

324 TURBINE GENERATORS

General Electric Co.—New two-color 16-page bulletin, No. GEA-5648, on turbine generators is available. It describes the new multistage turbine-generators rated from 200 to 1500 kw. Photographs showing the turbine-generators are included as well as schematic diagrams, cross-section diagrams, and governing control photographs.

325 HIGH-CAPACITY CHLORINIZER

Builders-Providence, Inc.—New bulletin No. 840-G27 on the new model HCVS volumetric chlorinizer describes this high-capacity visible flow chlorinizer which is designed to meter chlorine gas accurately at rates up to 6000 lb per 24 hr. The bulletin lists the many features of the chlorinizer and shows a cutaway drawing of the functioning parts. An easily readable diagram shows how the operation of the chlorinizer is carried out.

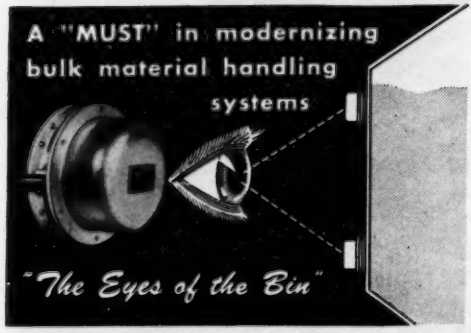
326 SOOT BLOWERS

Diamond Power Specialty Corp.—Catalog No. 1014, 48 pages, lists and describes Diamond soot blowers to meet your individual requirements. Included are automatic air puff soot blowers, steam soot blowers, short, long, and telescopic retracting soot blowers, air heater blowers, etc.

327 MECHANICAL CHART AND CONVERSION CALCULATOR

Addomatic Corp.—Engineers and students will find many uses for "Addomatic," a handy, pocket-size calculator that instantly gives fraction, decimal, and metric equivalents. Automatically adds or subtracts any combinations of these three systems, without the need for complicated prior conversion. Made of durable, lightweight aluminum.

The "Buyer's Catalog Guide" offers readers of MECHANICAL ENGINEERING an opportunity to secure advertisers' latest industrial literature available. In this issue there are 327 items to make selections from. For convenience an index may be found on pages 41 and 42. Select desired catalogs by number, fill in coupon on page 42 and mail promptly. *(Must be mailed on or before date given on coupon.)*



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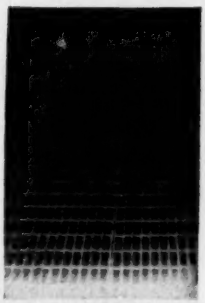

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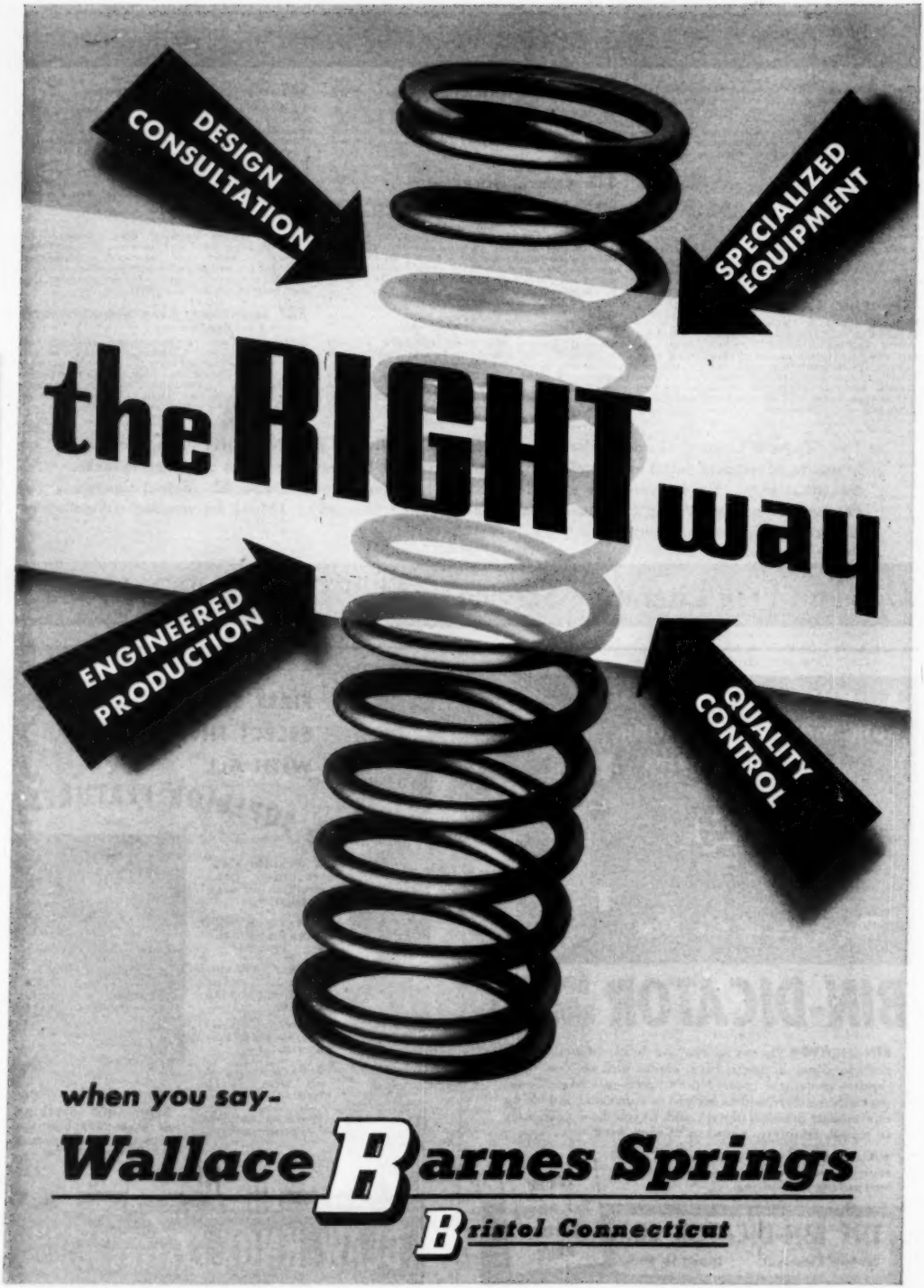
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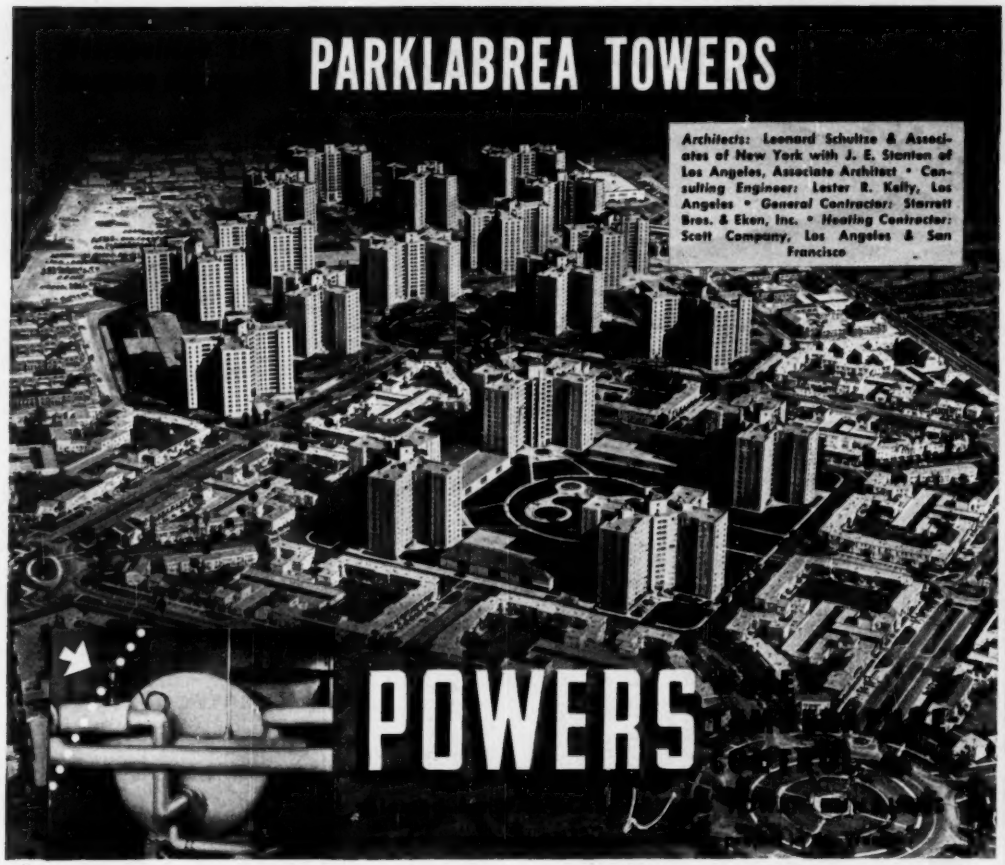

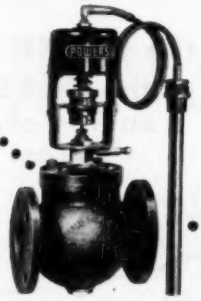

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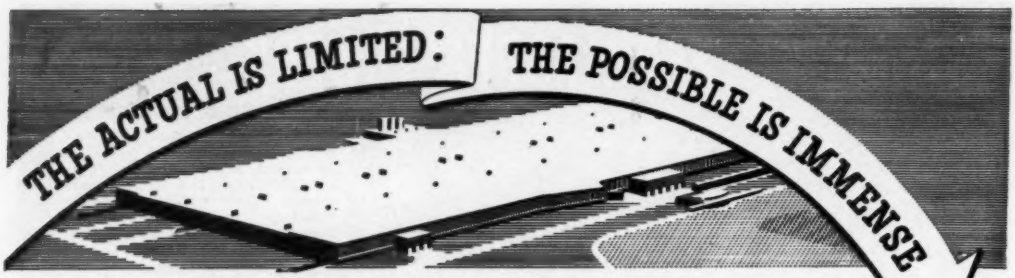

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Steel costs less per pound and fewer pounds are needed. The initial cost-saving advantage is 7 to 1 with steel, considering strength and safety factors alone.

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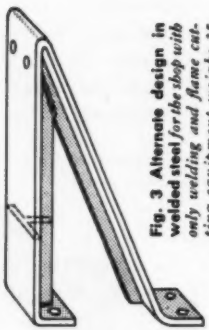

Fig. 3 Alternate design in welded steel *for the shop with only welding and flame cutting equipment weighs 35 pounds . . . costs only $4.70 . . . a saving of 48% over Figure 1.*

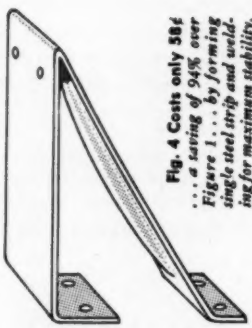

Fig. 4 Costs only 58¢ . . . a saving of 94% over Figure 1 . . . by forming single steel strip and welding for maximum stability. Weighs only 9 pounds.

the ACTUAL

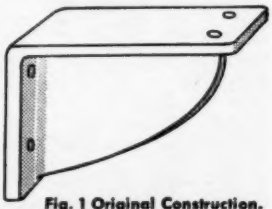

Fig. 1 Original Construction. *Machinery bracket weighs 39 pounds. Has ¼" and ⅜" sections. Requires milling and drilling. Costs $9.10.*

increasing the YIELD

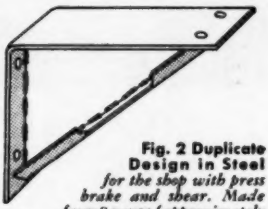

Fig. 2 Duplicate Design in Steel *for the shop with press brake and shear. Made from 8 gauge (approximately ⅛") sheet . . . saves 27 pounds of metal.* Costs $5.13 less than original construction.

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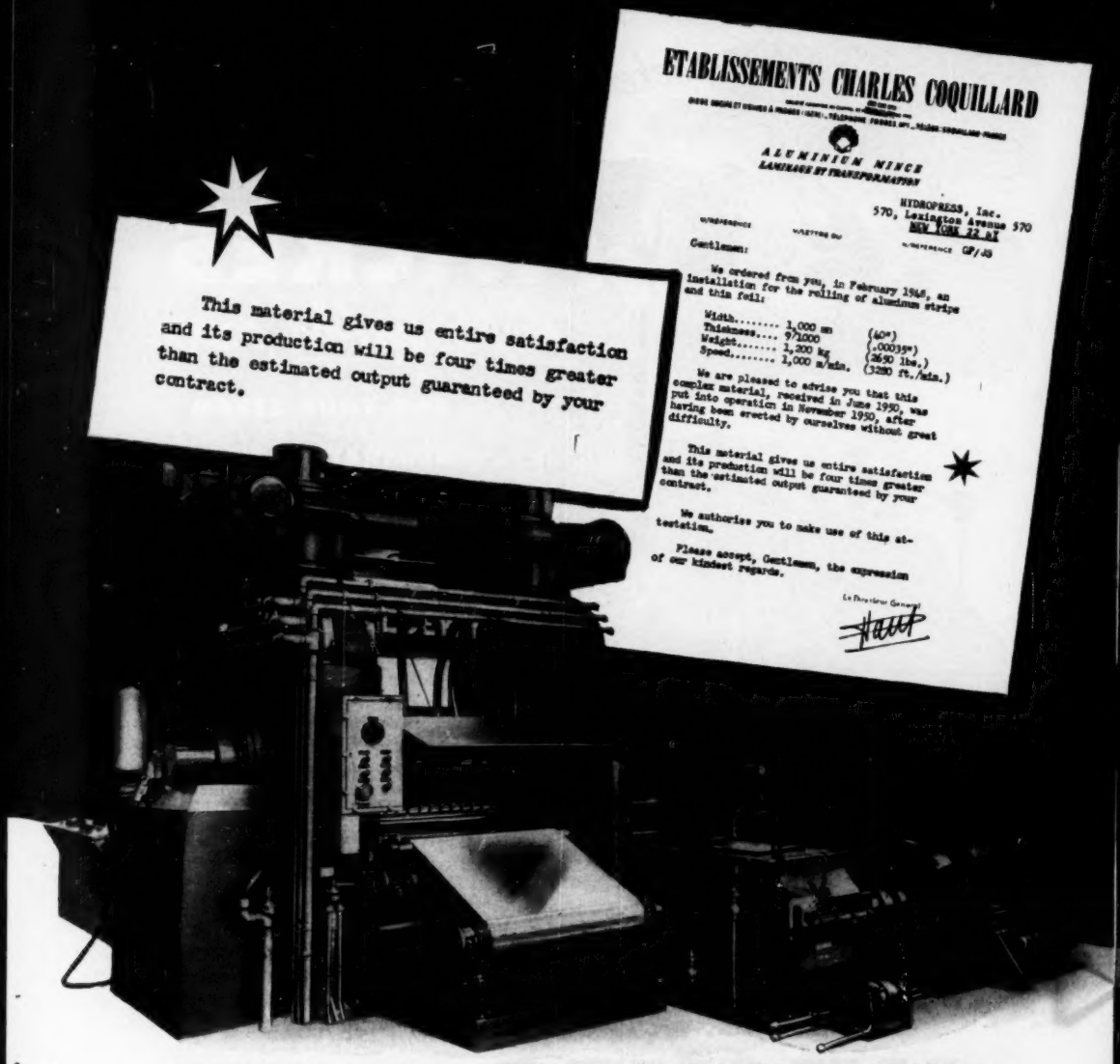
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NEW YORK 22 NY
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We ordered from you, in February 1948, an installation for the rolling of aluminum strips and this foil:
Width..... 1,000 mm (40")
Thickness.... 9/1000 (.00035")
Weight..... 1,200 kg (2650 lbs.)
Speed..... 1,000 m/min. (3280 ft./min.)
We are pleased to advise you that this complex material, received in June 1950, was put into operation in November 1950, after having been erected by ourselves without great difficulty.
This material gives us entire satisfaction and its production will be four times greater than the estimated output guaranteed by your contract.
We authorize you to make use of this attestation.
Please accept, Gentlemen, the expression of our kindest regards.

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FOR STRIP AND FOIL

- *speed more than 3000 FPM*
- *designed for one-man operation*
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We supply complete Rolling Mill Installations and the specialized Auxiliary Equipment that is indispensable for high-speed production of foil and other strip material to accurate gauge.

Four-High Cold Strip Mill For Roughing Aluminum Foil. A part of the High-Speed Cold Rolling Mill Installation for the production of aluminum foil 42" wide and .00025" thick supplied to Etablissements Charles Coquillard, France.

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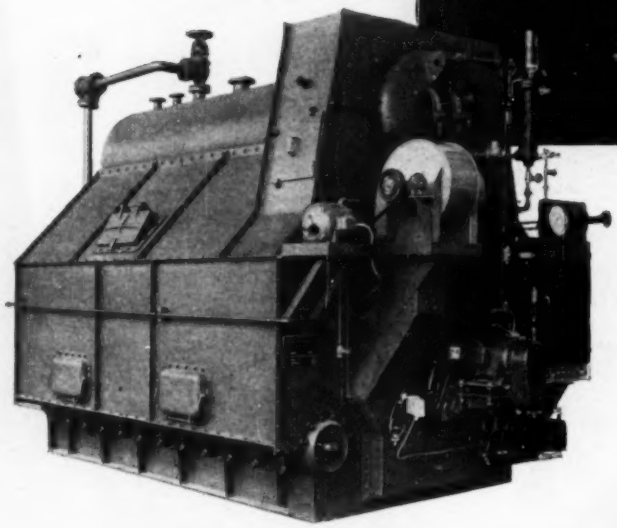

Steam power in a compact, efficient shop-assembled unit, custom-engineered to your exact steam generating requirements, ready for immediate installation! Wickes Type A Steam Generator is a steel-encased unit complete with baffles, refractories, pressure parts and firing equipment, designed to conserve headroom and floor space. Each furnace wall is a separate steam generator as well as an integral part of the boiler. There are no complicated headers or circulating tubes to require frequent maintenance or repair. Wickes Type A shop-assembled boilers are engineered for pressures up to 900 psi. with sustained steam production up to 35,000 lbs. per hour at 20 to 330 nominal h.p.

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WICKES

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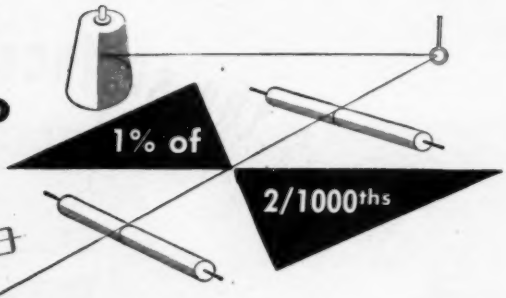

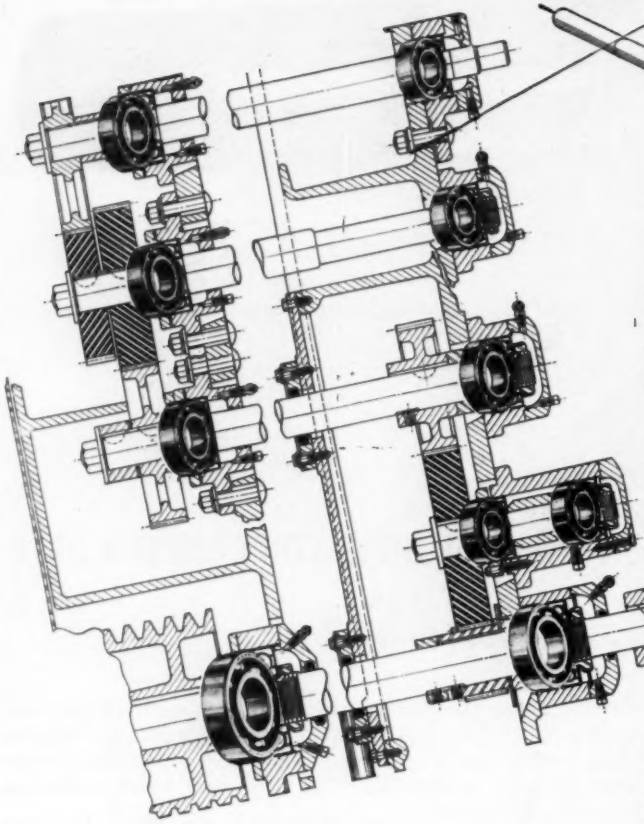

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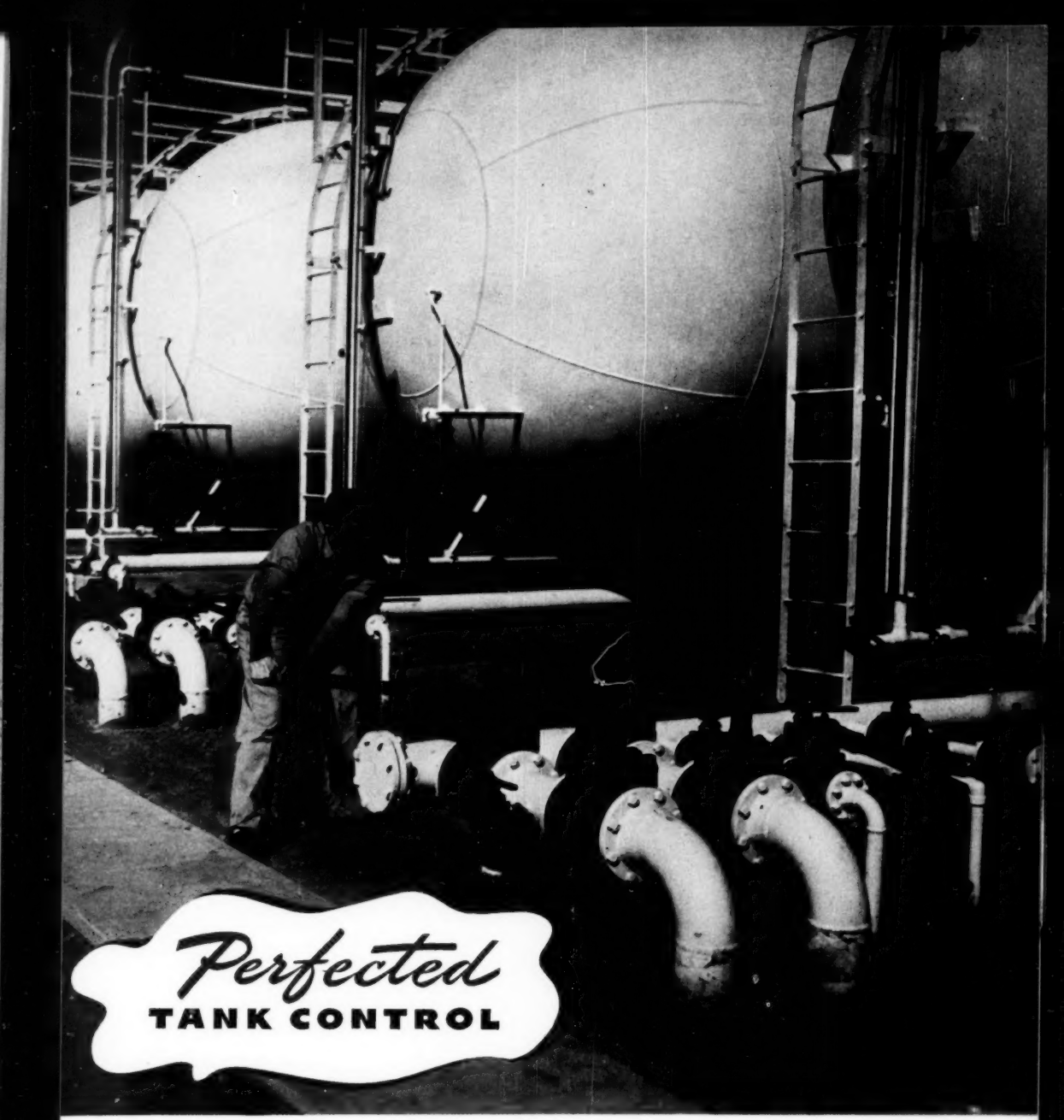
1950



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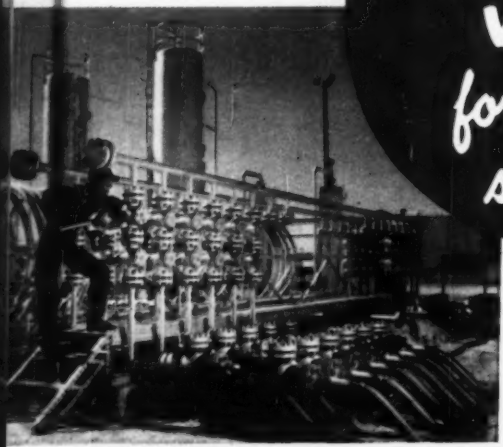

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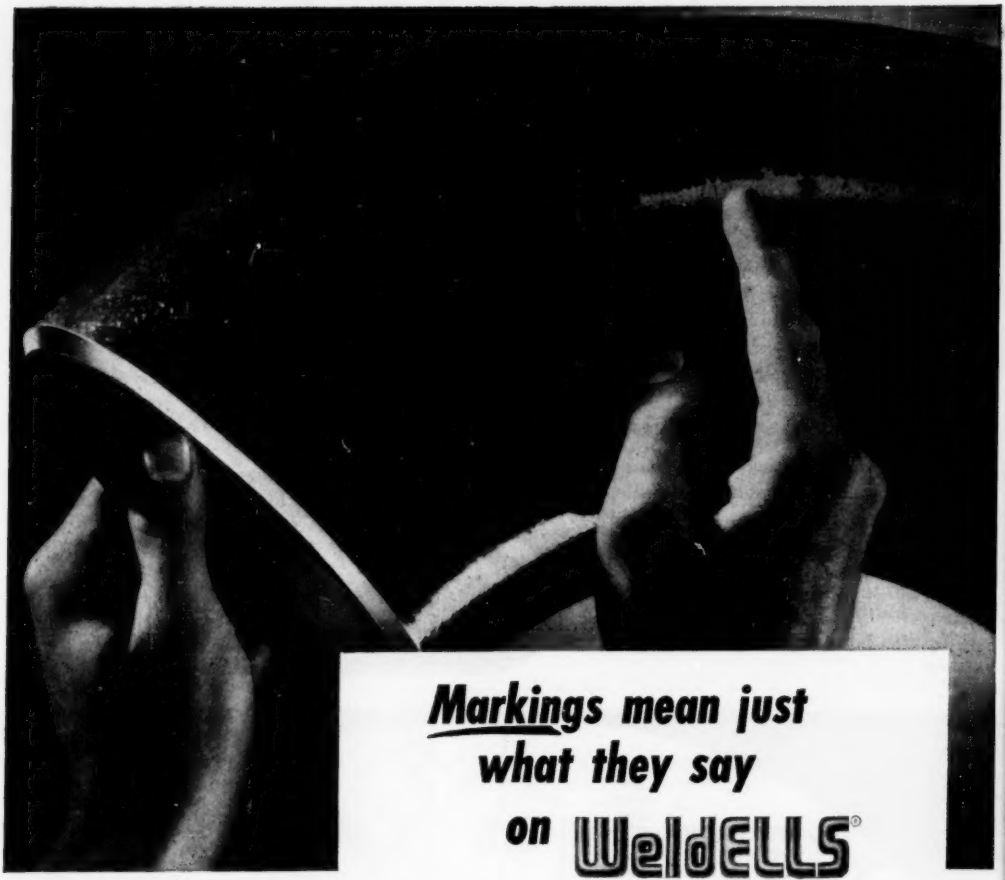

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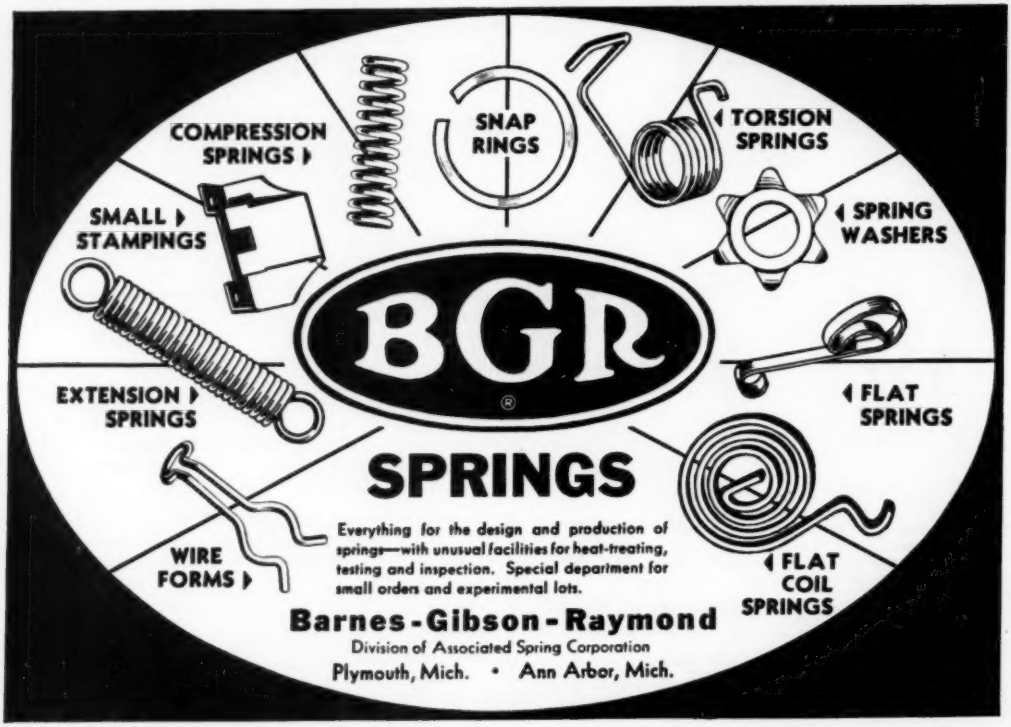

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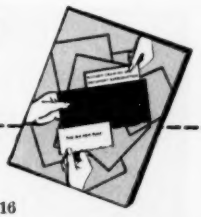

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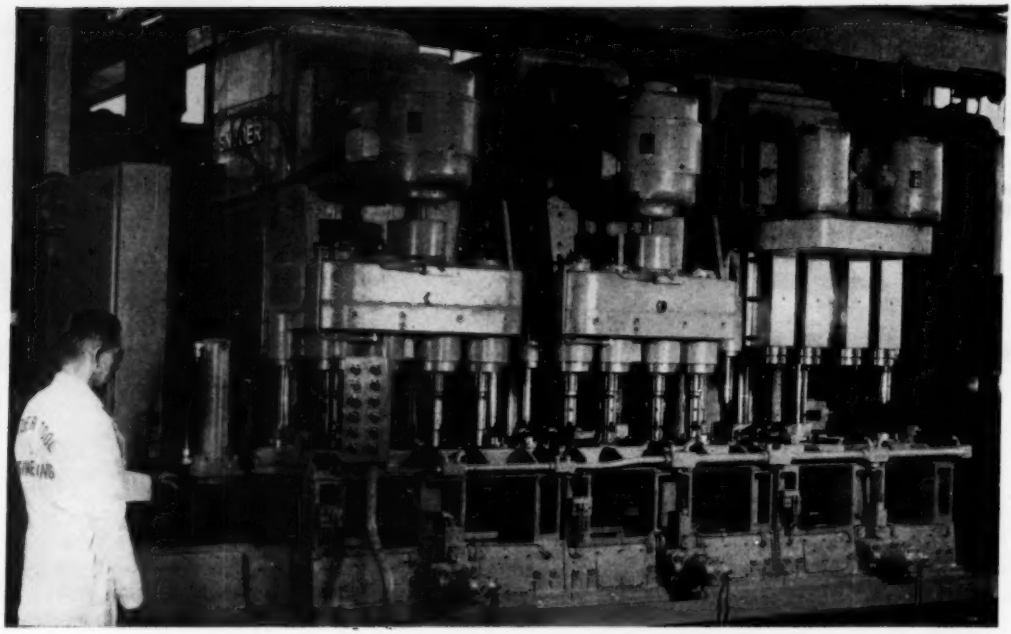
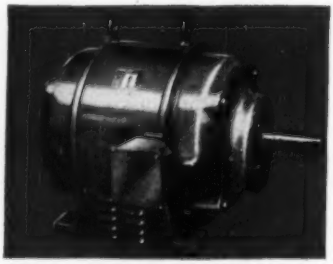
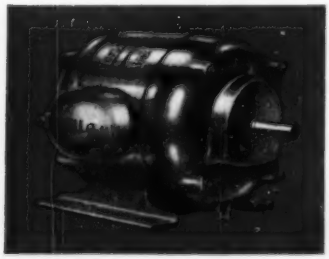


Three jobs done, instead of one!



Howell Type F Motor. A high slip, high torque motor designed for punching and boring operations. Sizes ½ to 200 H.P. in open frames; ½ to 125 H.P. in enclosed frames.



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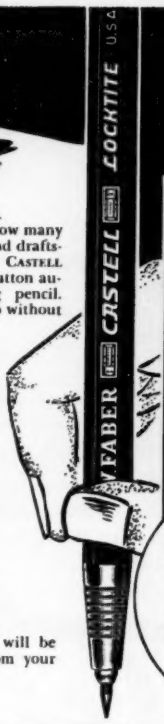

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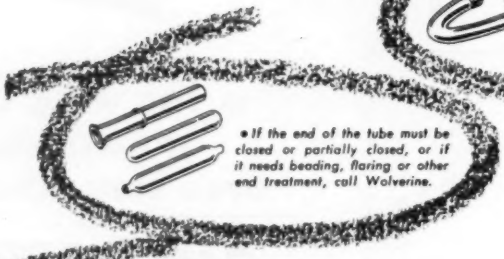

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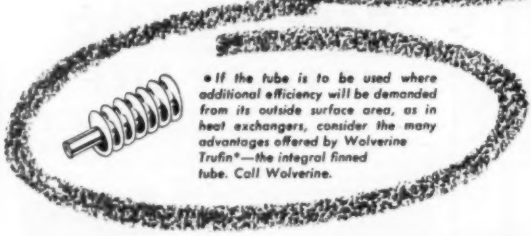

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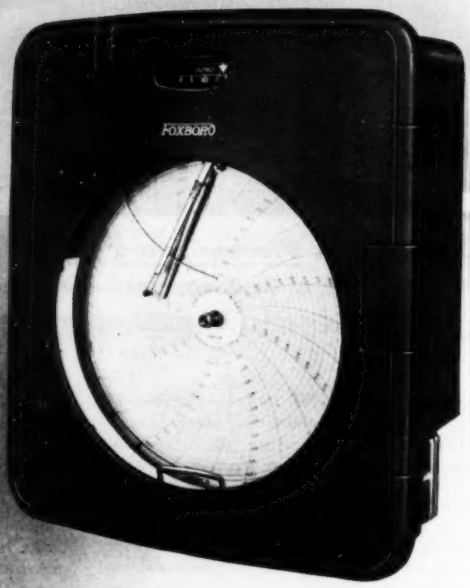

Ever since the origination of accurate humidity control by Foxboro, this Company has been foremost in the development of instrumentation for absolute humidity, relative humidity, moisture content and dew point . . . whether in gas, air, bulk materials or moving sheet stock. The high quality standards and complete diversity of Foxboro Instruments . . . backed by Foxboro's broad experience . . . offer you unmatched facilities for obtaining the most efficient system for your operation.

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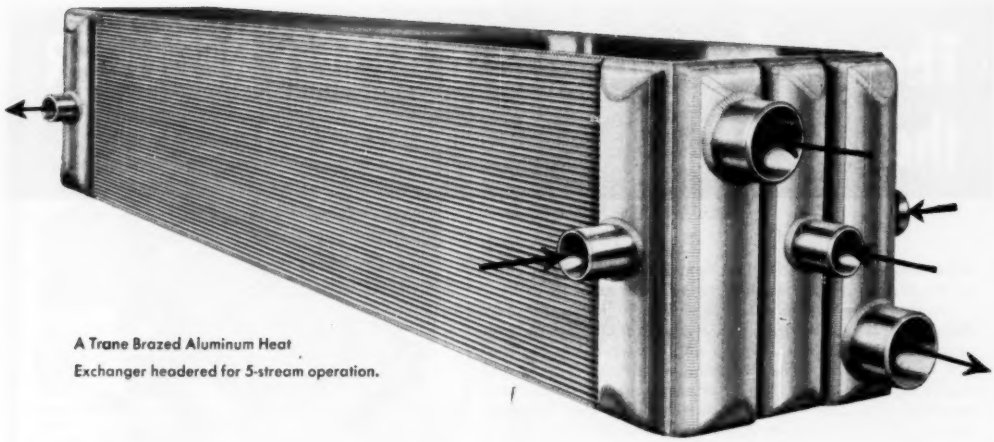


A Trane Brazed Aluminum Heat Exchanger headered for 5-stream operation.

This Single Brazed Aluminum Heat Exchanger

Handles FIVE Fluids Simultaneously

Trane Brazed Aluminum Heat Exchangers can be designed to handle up to five streams, or even more, at the same time – and meet the heat transfer needs of each stream accurately and efficiently.

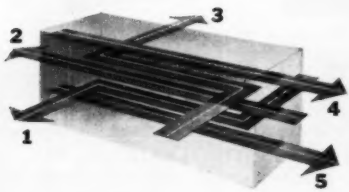
A single unit can be made to handle two, three, four, five or even more different liquids or gases. Headers are designed specifically for your installation. You can take any stream off at any point in the exchanger. You can split a stream, taking part off at one point in the unit at a given temperature and pressure, the rest off at another point at different conditions. The units provide just the heat transfer, pressure drop, volume, velocity, number and direction of passes needed for each stream.

And the units can meet these heat transfer specifications in the most limited space. That's because the Trane Brazed Aluminum Heat Exchangers pack up to 450 square feet of heat transfer surface into one cubic foot – nine times more than a tubular exchanger with ¾" tube.

Since a smaller unit can do a bigger job, *Brazed Aluminum Heat Exchangers can often replace tubular exchangers costing two or three times more and weighing four times more.*

These all-aluminum Trane Heat Exchangers are rugged, too. They take test pressures up to 1,000 lbs. per square inch, and temperatures from –300° to 500°F.

Whether the job calls for high or low temperatures or pressures, for one stream or many – as long as efficiency and economy are important – Trane Brazed Aluminum Heat Exchangers can be the answer. Contact your nearest Trane sales office or write direct.



Symbolic drawing, left, shows one of many ways in which a Trane Brazed Aluminum Heat Exchanger may handle up to five fluids simultaneously.

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It has frequently been said that: "any Reducer is only as good as the *experience and manufacturing facilities* of its maker" . . . *Gears are vitally important* in any Speed Reducer, but by themselves, they are *just Gears. A good Speed Reducer* presupposes also that it is properly engineered; it has the best anti-friction Bearings; the lubrication system is adequate and highly efficient; the Housing is designed for ruggedness, compactness and proper heat dissipation. The Unit is accessible—and it will deliver a high efficiency of Power Transmission over a long period of service life, with little or no attention.

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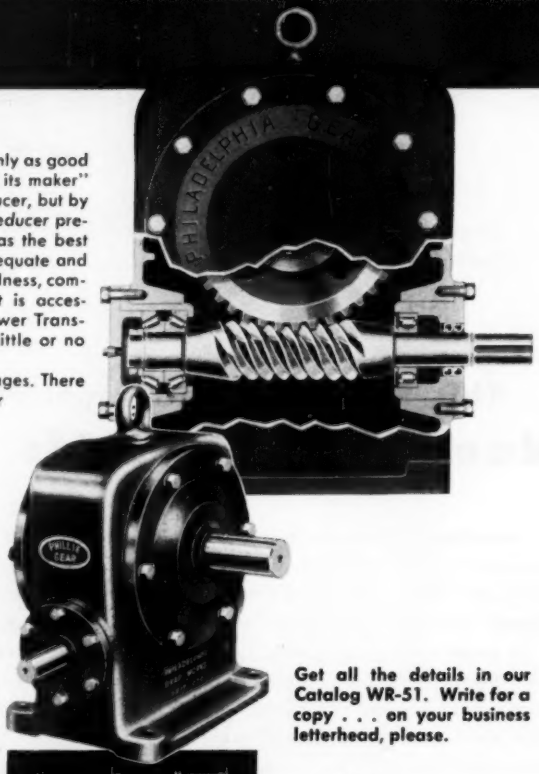

FEATURES . . .

OF THE TYPE A-T-O AND R-T-O PHILADELPHIA WORM GEAR SPEED REDUCERS

- Units are available with Worm "above" or "below" the Worm Gear, or in Vertical Units.
- Worms are made of alloy steel with carburized, hardened and tempered threads—both shaft and threads are accurately and smoothly ground after heat-treatment.
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- Bearings are anti-friction types (ball or roller) best suited for smooth, quiet, trouble-free operation (see cut-away illustration).
- Housings are quality grey iron—compact, neat, rigid and of ample radiating surface to prevent overheating.
- All units carry A.G.M.A. rating.
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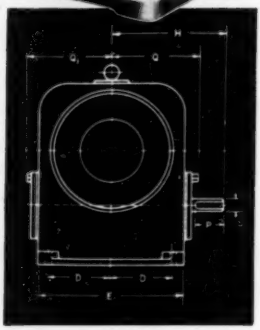
- Lubrication by splash system to all moving parts, in oil-tight housing.
- Efficiencies as high as 96%.



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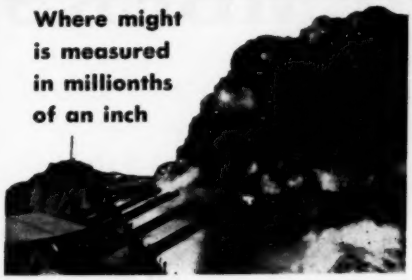

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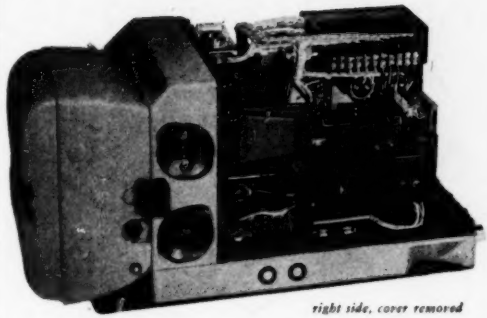

right side, cover removed

CONSOLIDATED'S 5-116 Recording Oscillograph, while costing considerably less than other instruments comparable in precision, construction, and versatility, produces records equal in quality to those of the Consolidated Type 5-114. It lacks only some of the features that may be dispensed with in many recording applications, such as the automatic record length control, visible wave-form scanning, etc. Specific instrumentation problems are welcomed by Consolidated's application engineering section, whose experienced engineers will analyze each problem individually and determine how dynamic instrumentation will answer questions of product design and performance.

CEC's 5-116 Recording Oscillograph records up to either 9 or 14 traces on 5", wide paper or film at recording speeds of ½" to 100" per second. Its removable feed-and-takeup magazine holds 125 feet of recording paper and is designed for the utmost loading and unloading convenience. Write for Bulletin CEC-1521-X16.

CEC's 5-114 Recording Oscillograph records up to 18 traces simultaneously on 7"-wide paper or film, is designed as the ultimate in precision, versatility, and operating convenience and incorporates many features available only through special accessories on many other oscillographs. Recording speeds from ½" to 115" per second and easily removable feed-and-takeup record magazines of 125, 250, and 600-ft. capacity offer an unusually wide application range. Write for Bulletin CEC-1500-X41.

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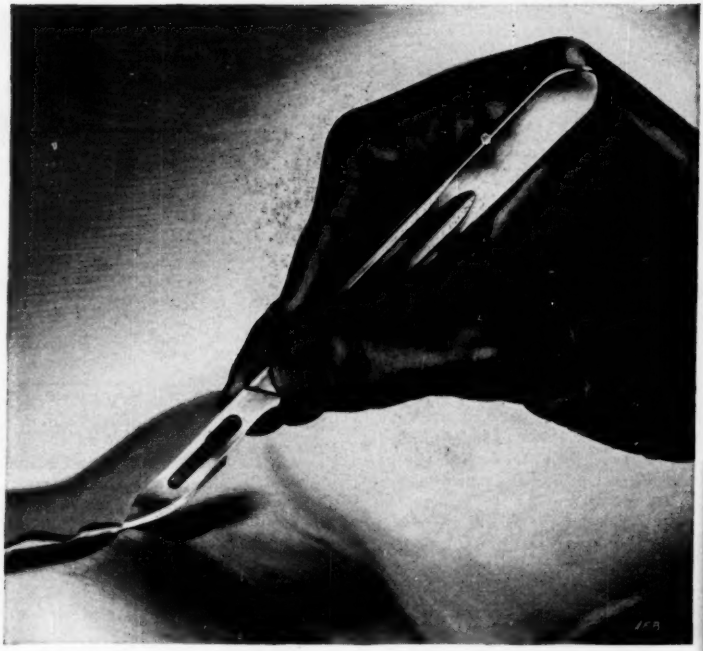
How many men on a surgeon's team?



On the team we have in mind, more than you can count. And none of them is a doctor!

We're talking about the team that produced this surgical knife blade handle, made by the Christy Surgical Company of Cincinnati, and used by surgeons throughout the world. Both the surgeons who use it, and Christy who makes it have very definite ideas about the properties of the metal from which it's made.

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We should like you to know that, on any product you may make of ANACONDA Nickel Silver, Copper or other Copper Alloys, we are as concerned with suggesting the best manufacturing procedure as well as helping you develop the best product. 51106

For technical assistance of any kind, or for a copy of Publication B-28 which provides detailed information on ANACONDA Metals and Metal Products, just write to The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.

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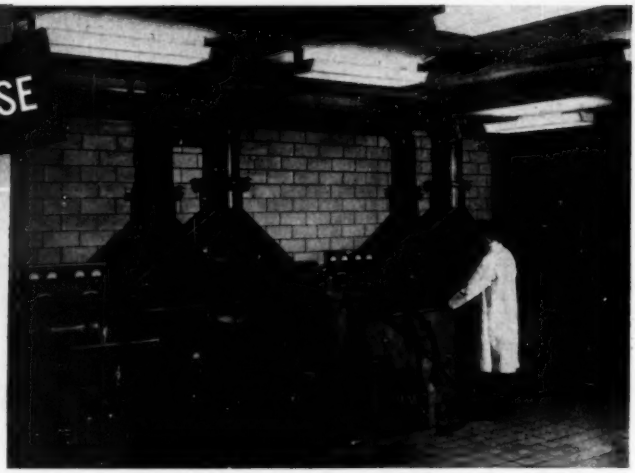


Five Sarco Type LSI indicating electric controls actuating solenoid valves to maintain any desired constant plating temperature on 100 gallon tanks of PR process pilot line at East Pittsburgh.

Our illustration shows a corner of the extensive pilot plating plant at Westinghouse's East Pittsburgh laboratories, where many improved plating processes have been developed and tested.

For example, this line of 100 gallon tanks was used to perfect the company's P.R.* process of plating to secure brighter finishes by periodic reversal of the plating current.

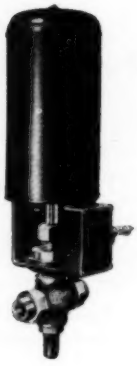
SARCO PLATING CONTROLS

Sarco Type LSI indicating electric temperature control for all kinds of plating. Long or short temperature ranges custom made as needed. Bulletin 1026.

Sarco Plating Controls were selected as a result of several years' experience in Westinghouse plants in Pittsburgh and elsewhere.

You can buy them with confidence. Low first cost, high accuracy, long life with minimum maintenance cost are outstanding features. Write for our Bulletins and the name of the Sarco man nearest you. His experience may include the solution to some of your control problems.

*For full information on this process see the article in the May 1st, 1950, issue of "Steel".



New: Sarcostat hydro-electric motor valve for use with LSI thermostats in place of solenoid valves. Powerful, direct thrust—no pilots or levers, slow opening and closing. Bulletin 1081.

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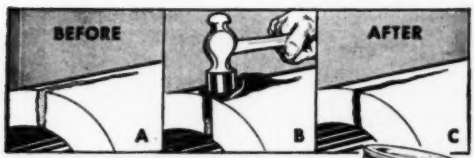

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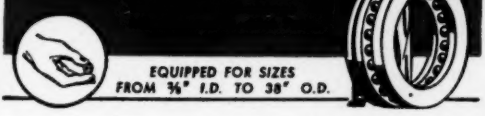

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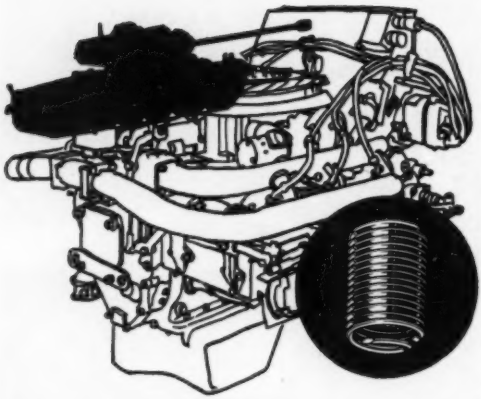

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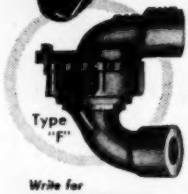

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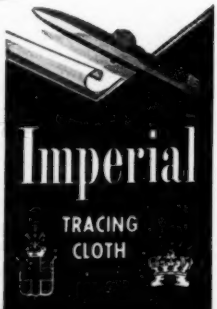

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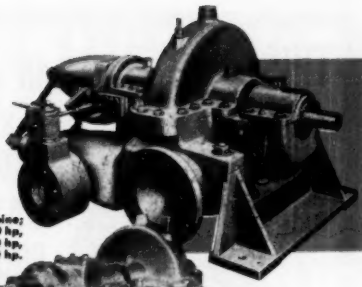
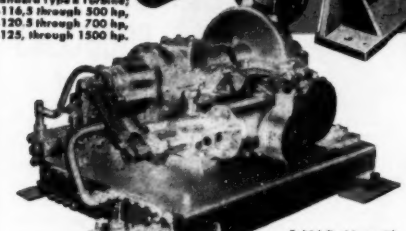
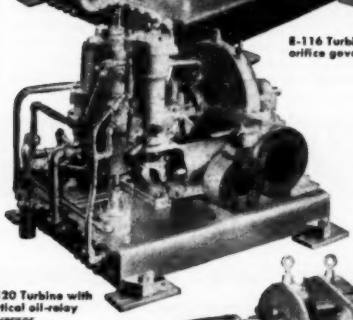


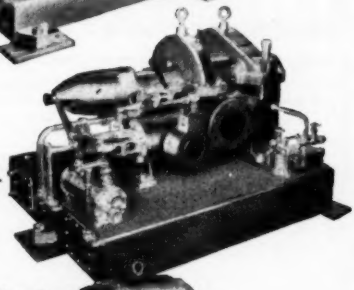
Standard Type E Turbine;
E-116, 5 through 500 hp,
E-120, 5 through 700 hp,
E-125, through 1500 hp.



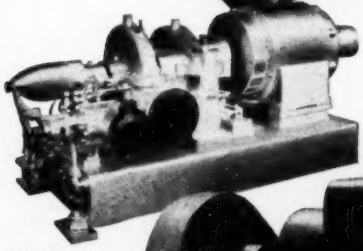
E-116 Turbine with orifice governor.



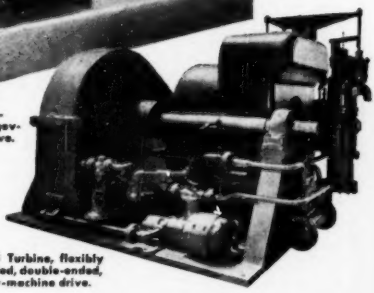
E-120 Turbine with vertical oil-relay governor.



E-116 Turbine, close-coupled gear; shaft governor.



E-120 Turbine, close-coupled gear; shaft governor—generator drive.



M-25 Turbine, flexibly coupled, double-ended, paper-machine drive.

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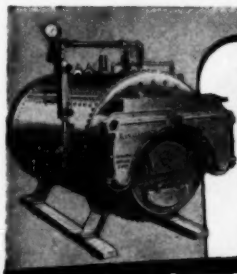

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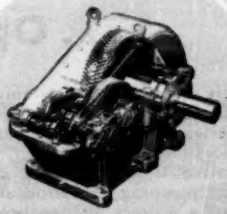

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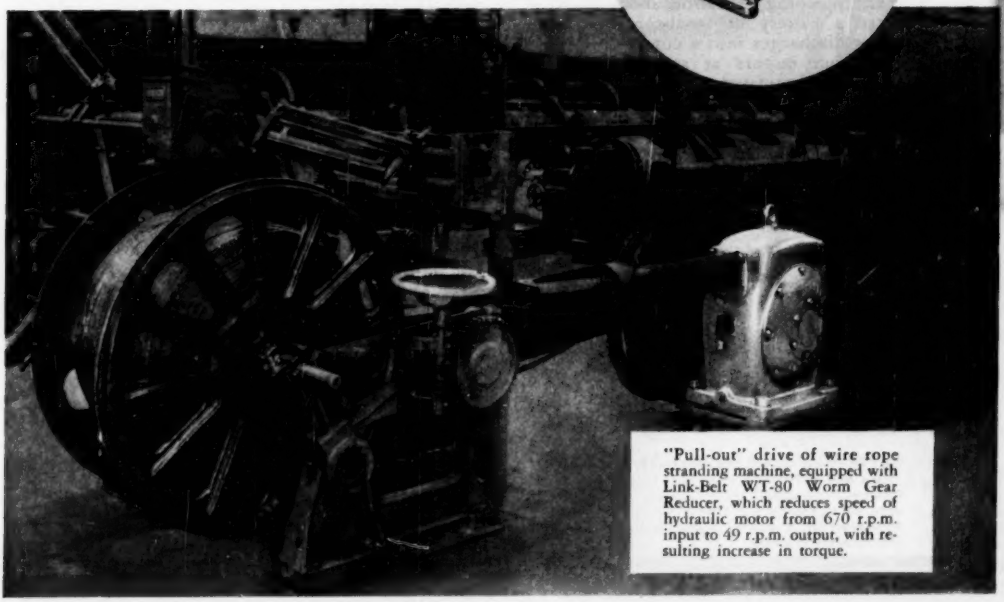

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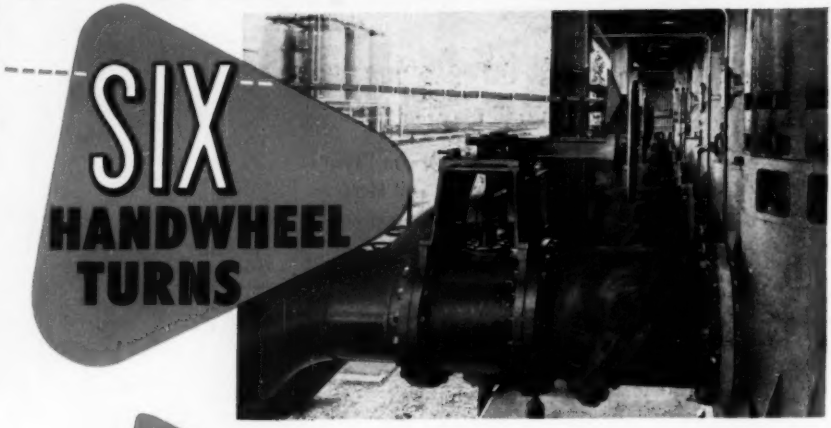

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This installation of twenty-inch valves in the water system to one of the large oil refineries in Louisiana is another example of R-S time-saving efficiency. Such ease of operation is an important consideration in any pumping operation and especially where a battery of synchronous driven pumps discharges into a common header. Burned-out motors at start-ups can be practically eliminated.

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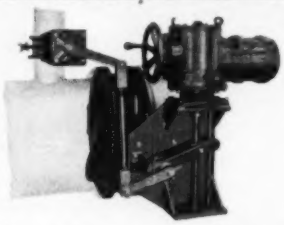
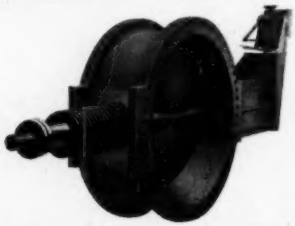


No. 798—Thirty-six inch and eight-inch R-S heavy duty valves of R-S "H" Metal at elevated temperatures for foundry cupola control. When the larger valve is wide open, the smaller valve is fully closed and vice versa. Slow operation is required, hence the motor operator with threaded reachrod.



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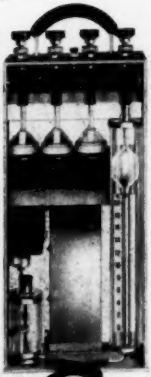

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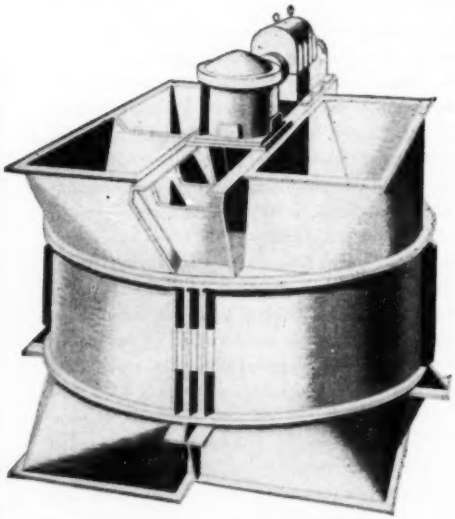

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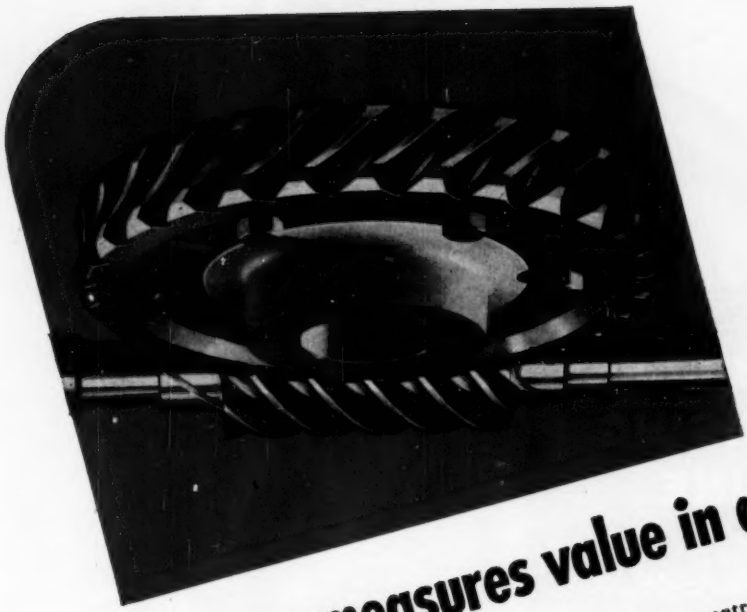

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FOR nearly 40 years, Cleveland has concentrated on the manufacture of worm-gear drives. In specializing on a single type of gearing, this Company has emphasized one value above others—dependability—measured by the yardstick of performance on the equipment of its customers.

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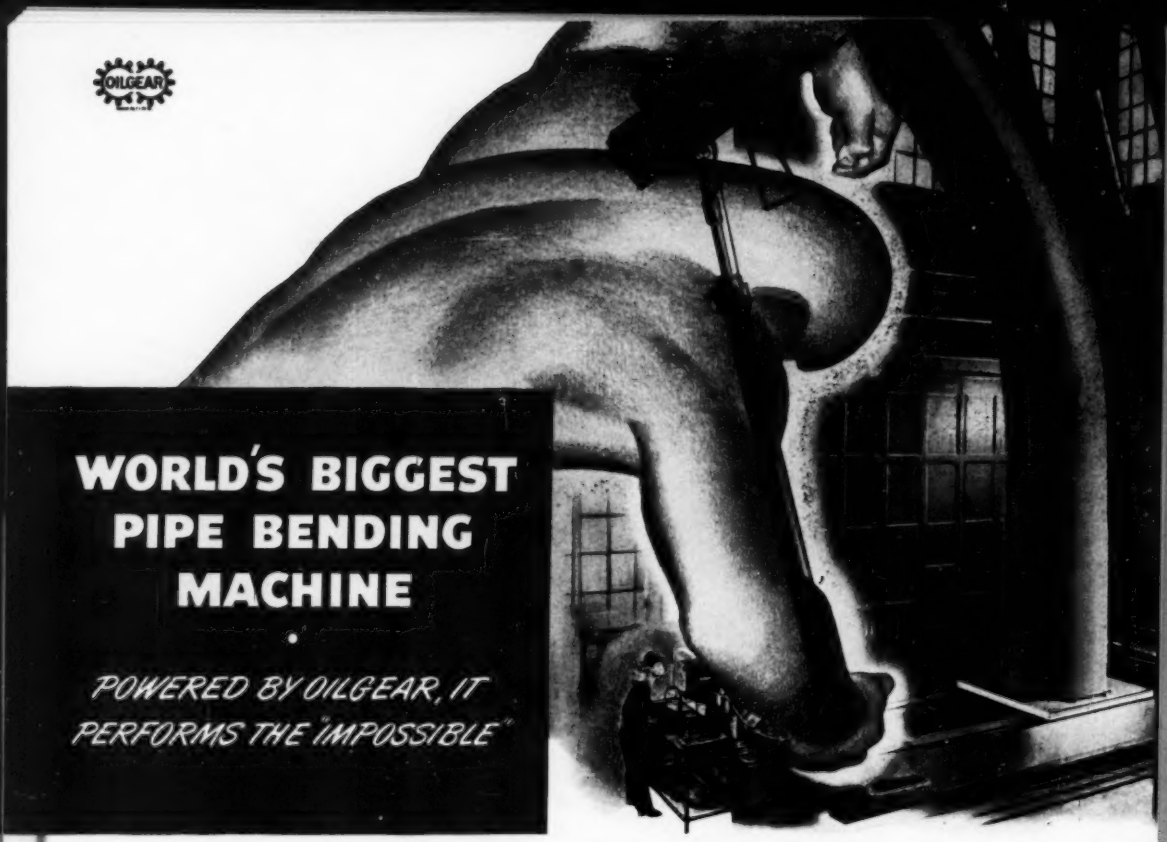

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Prior to the advent of the machine pictured above it was just not possible to bend a pipe over 30 inches in diameter without its buckling and distortion beyond the point of usefulness.

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Oilgear

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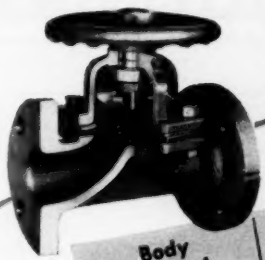
Fluid	Concentration	Temp.	Type of Valve	Valve Material
1 Sulphuric Acid	20%	120 F.		
2 Sulphuric Acid	100%	180 F.		
3 Hydrochloric Acid	32%	80 F.		
4 Hydrofluoric Acid	50%	125 F.		
5 Beer		200 F.		
6 Oxygen		Ambient		



We supplied Grinnell-Saunders Diaphragm Valves with . . .

Body Material	Diaphragm Material
1 Rubber lined	Natural rubber
2 Cast iron	KEL-F
3 Glass lined	Butyl
4 Magnesium	KEL-F
5 Polished bronze	White diaphragm
6 Cast iron*	Neoprene

*For oxygen service a high flash point lubricant is supplied. All valves for oxygen service are subjected to 300 lb. air underwater test.

In several of these cases other body materials or diaphragms would serve as well. But the really important fact is the unmatched versatility of Grinnell-Saunders Diaphragm Valves in handling corrosive fluids, gases, compressed air, food and suspended solids . . . in lines where corrosion, abrasion, contamination, clogging, leakage and maintenance are problems.

Grinnell-Saunders Valve bodies are stocked in cast iron, malleable iron, stainless steel, bronze, and aluminum, with other materials available on special order. Valve bodies can be lined with lead, glass, natural rubber or neoprene. Diaphragms are available of natural rubber and a number of synthetics to suit particular service conditions.

The Grinnell-Saunders Valve Division will be pleased to submit recommendations upon receipt of complete information covering service conditions.

Features of the Grinnell-Saunders Diaphragm Valve

- diaphragm absolutely isolates working parts from fluid
- diaphragm lifts high for streamlined flow in either direction
- diaphragm presses tight for positive closure
- body, lining and diaphragm materials to suit service
- simple maintenance—diaphragm easily replaced

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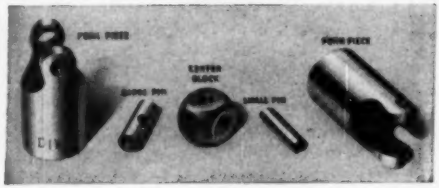

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- *Adjustable valve operating position*
- *No critical adjustment for tight valve seating*
- *Completely adaptable to steam and air blowing, interchangeably*
- *Low pressure drop*
- *Adjustable pressure control on each individual blower*

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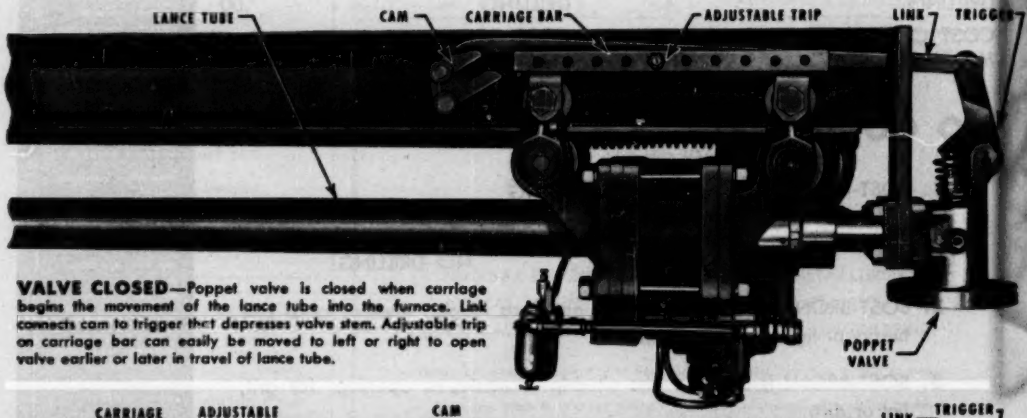

VALVE CLOSED—Poppet valve is closed when carriage begins the movement of the lance tube into the furnace. Link connects cam to trigger that depresses valve stem. Adjustable trip on carriage bar can easily be moved to left or right to open valve earlier or later in travel of lance tube.

VALVE OPEN—Valve was opened when trip engaged cam and rotated it to position shown, thus moving link to left which caused trigger to depress valve stem and open valve. Valve remains latched open until carriage retracts lance tube and trip re-engages cam returning it to its original position.

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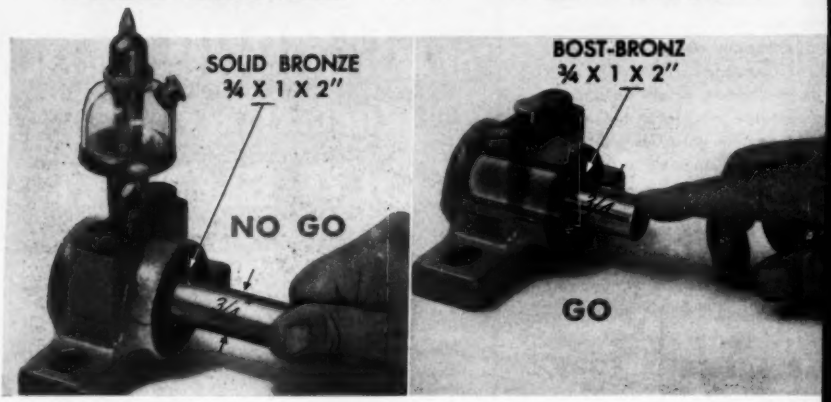

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See our ad in this issue, page 26

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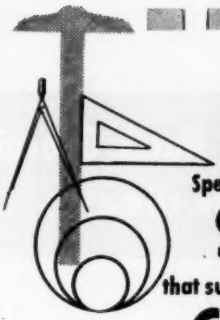

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Work is varied and interesting, requiring a wide range of engineering interests along with an ability to work with a small congenial staff.
The man we have in mind should have approximately 5 years' industrial experience and be not over 30 years of age.
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SENIOR MECHANICAL ENGINEER—At least three (3) years' post college experience, Electro-Mechanical, servo unit design, precision gear trains, etc. Established company, New York City. Write ME 1731, 221 W. 41 St., N. Y. 18.

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PROFESSORS OF ME—The TECHNION (Institute of Technology) Haifa, Israel proposes to appoint two professorships to the faculty of Mechanical Engineering. One of the positions requires special knowledge of APPLIED THERMODYNAMICS, also a Professor of PRODUCTION ENGINEERING. Applicants should have first-rate professional and academic qualifications, be willing to integrate themselves into the life of the country and, in due course, to teach in Hebrew. Applications with full details should be sent, for transmission to Haifa, to: The American Technion Society, 154 Nassau Street, New York 38, N. Y.

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JR. PROCESS ENGINEER—Large New York City concern has opening for graduate M.E. or C.E. Minimum two (2) years of Process design and layout work in conjunction with food or Chemical industry. Drawing board experience in this type of work desirable. Work involves process batch weighing conveyors, pneumatic conveying of materials, blending and mixing equipment, Liquid handling, etc. Salary $350 per month. 5-day week. Age about 25. Submit detailed resumé of experience, education, age, present salary, etc. Address CA-3671, care of "Mechanical Engineering."

PROCESS ENGINEER—With large New York City concern. Graduate M.E. or C.E. with minimum of five (5) years' experience in materials handling and process design and layout work in food or chemical industry. Experience in drawing board design and specifications writing desirable. Some experience in the following necessary: Automatic process batch weighing. Liquid Handling Process design such as piping, pumps, tanks, automatic controls. Salary $550 per month. 5-day week, age 35-45. Submit detailed resumé of experience, education, age, present salary, etc. Address CA-3672, care of "Mechanical Engineering."

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DESIGN ENGINEER—Large New York City concern has opening for graduate Chemical Engineer. Several years' experience in food processing industry including operation, installation and maintenance of mechanical equipment. Salary $550 per month. 5-day week. Age 35-45. Submit detailed resumé of experience, education, age, present salary, etc. Address CA-3675, care of "Mechanical Engineering."

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PROFESSOR OF MECHANICAL ENGINEERING wanted—M.E. with Master's degree plus power plant experience to be head of Mechanical Engineering Department. Salary $5700 on 9 months basis. Send application to Professor E. L. Lium, University of North Dakota, Grand Forks, North Dakota.

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A booklet giving more complete information concerning the principal conditions of the work and the admission conditions to the bid can be asked for to ELECTRICITE DE FRANCE, Région d'Equipement Thermique 1, n°5 Avenue du Coq, PARIS (9°) France.

The bids, made according to the prescriptions of the above mentioned booklet, ought to be written before the 1st December 1951.

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B.S., M.E., Idea man, machine design, piping layout, stress analysis, pressure vessels, heat exchange.

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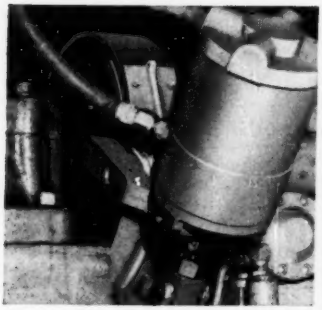

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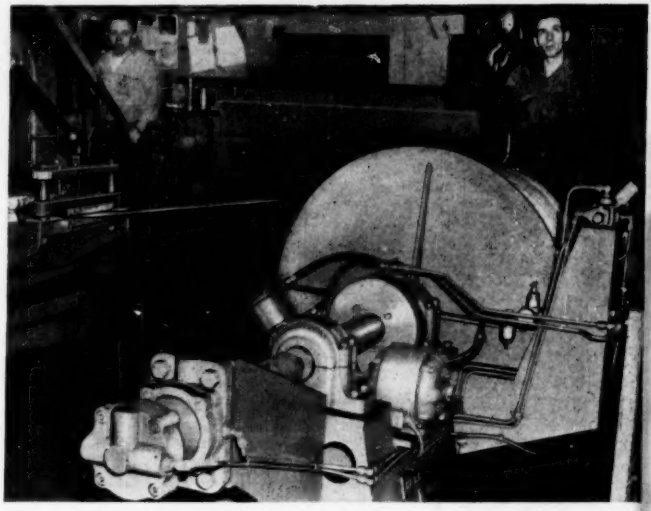

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Controlled rotation is often the key to high production output! Dependable, responsive brakes eliminate breakdowns—keep machines humming at a steady clip! Recognizing this important fact, alert manufacturers are standardizing on smooth, efficient TDA Brakes! They're taking full advantage of the more than 40 years of experience offered by TDA Brake Division—experience concentrated in a highly competent staff of brake technicians. Let TDA Brake Division put its forces to work in developing the specific type of brake you need to meet your exact requirements! Mail the coupon below for more information on how TDA Brakes can be applied to your product.

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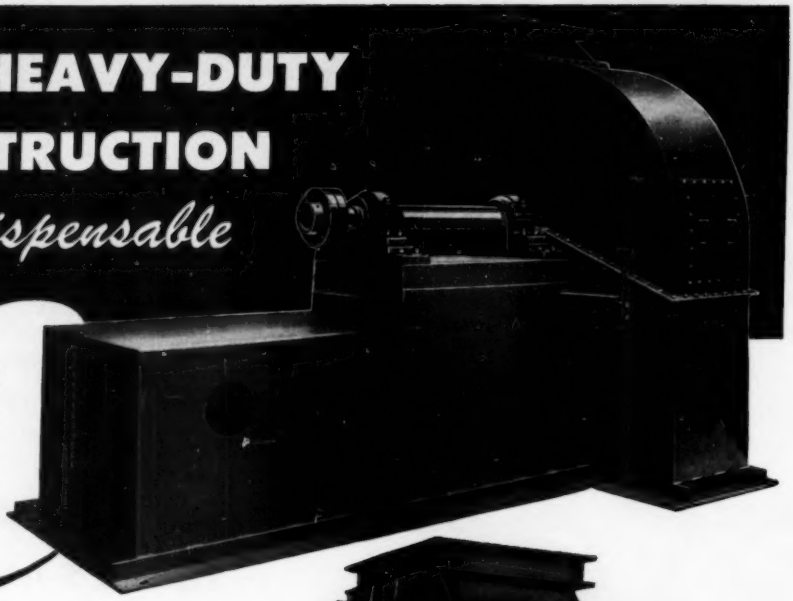

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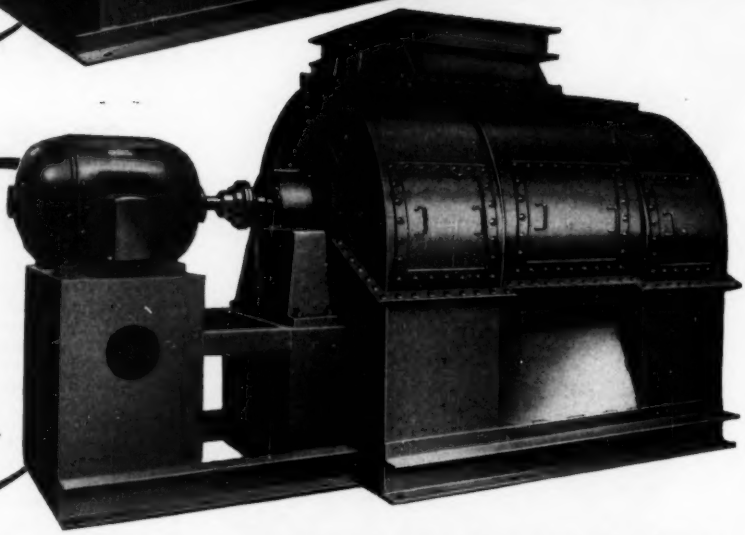

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YOU CAN'T TOLERATE PROCESS AIR FAILURES IN DEFENSE PRODUCTION

Durability plus! . . . fan equipment to master the toughest assignments . . . fans to meet any size, any type of air handling need! **Clarage HEAVY-DUTY equipment** is built above and beyond the demands of average service. It is the make of equipment so many engineers in industry prefer for their **most important fan jobs.** We welcome your inquiry for any desired data.

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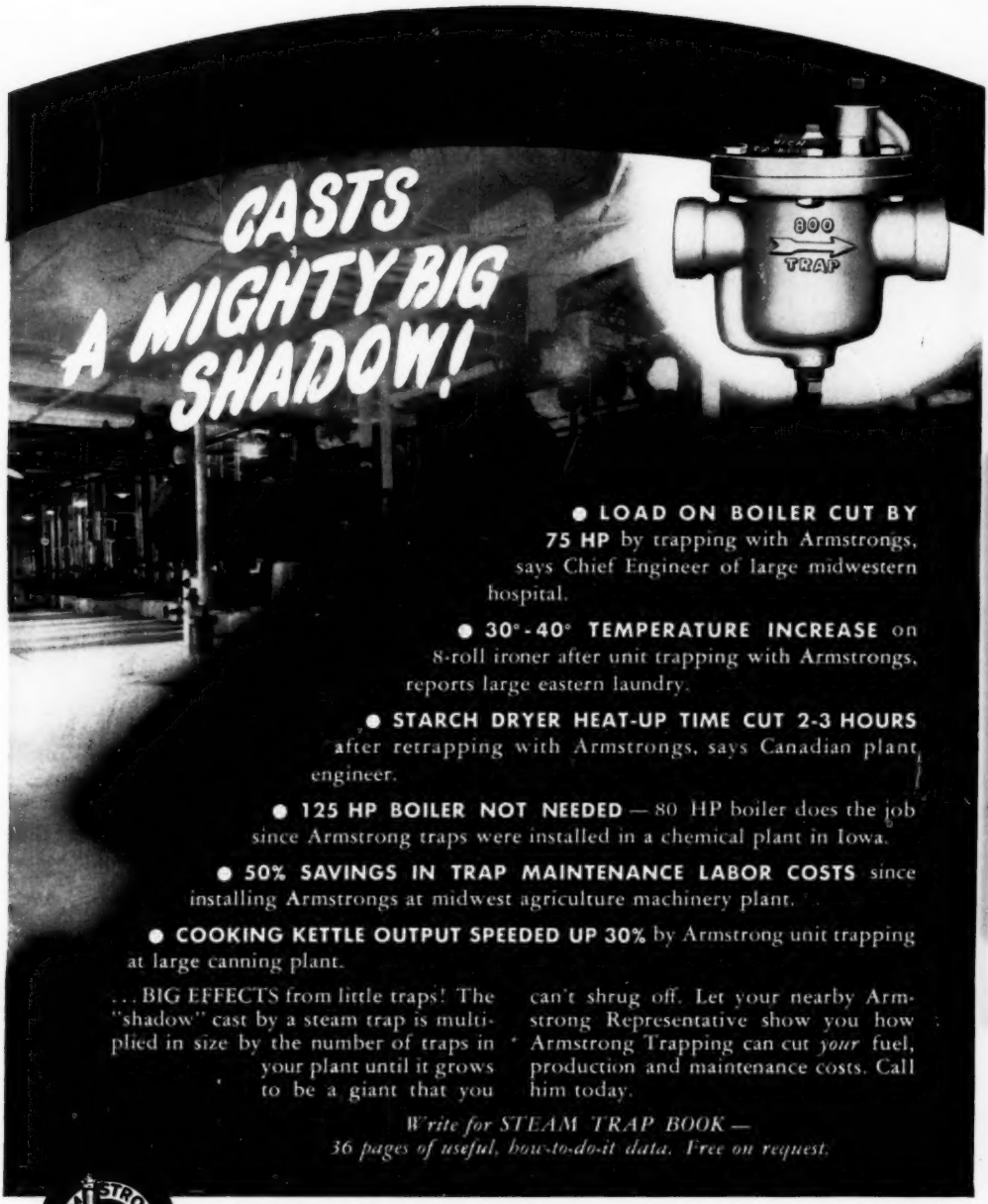

● **LOAD ON BOILER CUT BY 75 HP** by trapping with Armstrongs, says Chief Engineer of large midwestern hospital.

● **30°-40° TEMPERATURE INCREASE** on 8-roll ironer after unit trapping with Armstrongs, reports large eastern laundry.

● **STARCH DRYER HEAT-UP TIME CUT 2-3 HOURS** after retrapping with Armstrongs, says Canadian plant engineer.

● **125 HP BOILER NOT NEEDED** — 80 HP boiler does the job since Armstrong traps were installed in a chemical plant in Iowa.

● **50% SAVINGS IN TRAP MAINTENANCE LABOR COSTS** since installing Armstrongs at midwest agriculture machinery plant.

● **COOKING KETTLE OUTPUT SPEEDED UP 30%** by Armstrong unit trapping at large canning plant.

... BIG EFFECTS from little traps! The "shadow" cast by a steam trap is multiplied in size by the number of traps in your plant until it grows to be a giant that you can't shrug off. Let your nearby Armstrong Representative show you how Armstrong Trapping can cut *your* fuel, production and maintenance costs. Call him today.

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ARMSTRONG MACHINE WORKS 894 Maple Street, Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

Production stamina, tool-room accuracy ..lathe gets both with TIMKEN® bearings

THIS "Economy" lathe is designed to fill a specific demand for a medium-priced lathe which has these two qualities: ruggedness for general production work and accuracy for tool-room service. To insure these two qualities, Rockford Machine Tool Co. mounts the spindle and gear shafts on Timken® tapered roller bearings.

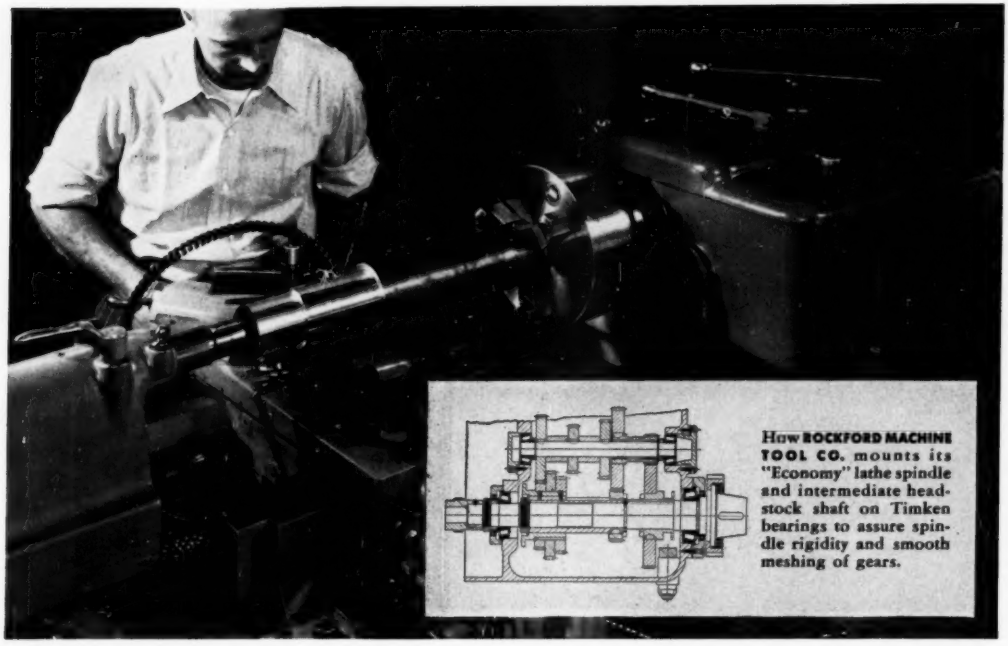
With Timken bearings, the spindle is held in rigid alignment. Precision is maintained. Gears mesh smoothly — with minimum wear even under the heaviest loads.

Because of their tapered construction, Timken bearings take radial and thrust loads in any combination. Line contact between rollers and races provides extra load-carrying capacity. The true rolling motion and incredibly smooth surface finish of Timken bearings practically eliminate friction.

Timken bearings hold shaft and housing concentric, making closures more effective. Because they are (1) precision manufactured, (2) engineered for the job, (3) made of Timken fine alloy steel, Timken bearings normally last the life of the machine.

When you buy or build machine tools, be sure they are equipped with Timken bearings. No other bearing can give you all the advantages of the Timken bearing. Look for the trade-mark "Timken". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How ROCKFORD MACHINE TOOL CO. mounts its "Economy" lathe spindle and intermediate headstock shaft on Timken bearings to assure spindle rigidity and smooth meshing of gears.

FINISHED TO CLOSER TOLERANCES

Finishing to incredible smoothness accounts for much of the precise, smooth rolling performance of Timken bearings. This honing operation is typical of the amazingly accurate manufacturing methods of the Timken Company.

The Timken Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ▯ AND THRUST →▯← LOADS OR ANY COMBINATION →✳←